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Identifiers-Texas

Data about the farm machinery mechanics trade were obtained from 51 managers of farm machinery dealerships in Texas to determine the content that should be included in courses of study designed to train persons to enter the occupation, and to obtain information about the occupation that would be useful to persons considering the trade as an occupational goal. All data were collected by teachers of vocational agriculture utilizing the personal interview technique. Some major conclusions were: (1) concerted efforts be made to encourage young men to select a career in the mechanics trade, (2) persons selected to be trained as mechanics demonstrate the aptitude to become competent, (3) efforts be made jointly by educators, industry and other groups to expand mechanics training programs, (4) programs for training mechanics be staffed with persons who have trade competence, and (5) courses of study include experience designed to develop the personal attributes needed by competent mechanics. (DM)

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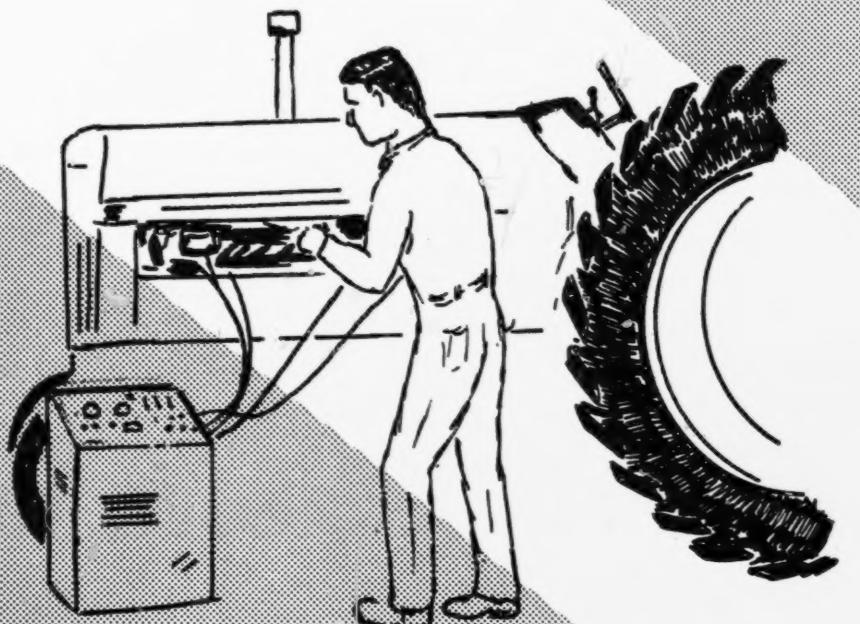
OPPORTUNITIES AND REQUIREMENTS FOR ENTRY INTO THE AGRICULTURAL MACHINERY MECHANICS TRADE



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Sponsored Cooperatively by
Occupational Research Coordinating Unit
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and
Texas Agricultural Experiment Station

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OPPORTUNITIES AND REQUIREMENTS FOR ENTRY INTO THE AGRICULTURAL MACHINERY MECHANICS TRADE, Final Report.

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January, 1969

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J. D. Nixon, Beaumont
A. A. Johnson, Beaumont
Larry Shupak, Crockett
Lester Smith, Meridian
Harold Gilbert, Palestine
A. D. Wheat, Cleburne
Cecil Williams, Huntsville
Shepherd D. Brazil, San Benito
Cecil Clendenin, Alice
Leon Tomlin, Taft
Alton Calvez, Victoria

Respondents

J. M. Ford - Texas Farm Machinery, Inc. - Plainview
Fred Howard - E. R. Hufstedler & Son - Plainview
John W. Speck - W. O. Speck Machinery Co. - Plainview
Ira A. Welch - Texas Farm Machinery, Inc. - Plainview
Jim Cox - Fry and Cox, Inc. - Muleshoe
James O. Elder - Whitt, Watts, and Rempe Imp. - Muleshoe
Lee Roy Hughes - Fry and Cox, Inc. - Muleshoe
H. E. Reeder, Jr. - Muleshoe
Glen Rowland - Muleshoe
Roy D. Whitt - Whitt, Watts, and Rempe Imp. - Muleshoe
Alton Anderson - Tulia Farm Equipment, Inc. - Tulia
R. C. Hill - Hill-Featherston Co. - Tulia
J. W. Kendrick - Ziegler Wimberly, Inc. - Tulia
Bill Workman - Workman Machinery Co. - Tulia
Ed Workman - Workman Machinery Co. - Tulia
John Fielder - Hays Implement Co. - Hereford
E. A. Guinn - H & W Implement, Inc. - Hereford
John Hall - Davis Implement Co. - Hereford
Ernest O. Neff - Case Power and Equipment - Hereford
Cecil Oglesby - Hays Implement Co. - Hereford
Jim Tucker - Case Power and Equipment - Hereford
Thomas Carlo - Mason Equipment Co. - El Paso
Cleo Davis - The Myers Company - Fabens
Troy McCombs - The Myers Company - El Paso
William Vincent - Romney Implement Co. - El Paso
Glenn Warwick - The Myers Company - El Paso
Herman Cox - Jones County Implement Co. - Stamford
Jessie Teichelman - Jones County Implement Co. - Stamford
Leland A. Thane - Doc Jones Implement - Stamford
G. W. Viers - Stamford

Respondents (cont.)

C. K. Dozier - Dozier Tractor Implement, Inc. - Pecos
B. W. Powell - Powell and Son, Inc. - Pecos
A. D. Woody - Pecos Tractor and Picker Service - Pecos
Jack D. Brooks - Brownfield Tractor Co. - Brownfield
Wayne Crittenden - Brownfield Tractor Co. - Brownfield
Jim Ervin - B. E. Implement Co. - Brownfield
Preton Hester - Hester Implement Co. - Brownfield
Frank Melcher - Terry County Tractor - Brownfield
Albert W. Boeker - T & T Company - Bryan
Melton R. Patterson - Cen-Tex Tractor Co. - Bryan
Jess J. Caldwell - International Harvester Co. - Bryan
Alvin Carl Fulton - International Harvester Co. - Bryan
Royce C. Johnson - Johnson Brothers, Inc. - Columbus
D. J. Potter - Potter Ford Tractor Co. - Columbus
Dick Nutter - Conroe
J. M. Stoggs - Conroe Truck & Auto - Conroe
Hubert Brandt - Brandt Brothers Equipment Co. - La Grange
Paul J. Kleiber - La Grange Tractor & Implement Co. - La Grange
J. E. Morgan - Morgan Implement Co. - Plum
R. F. Bailey - Hugh Robison Farm Machinery - Navasota
R. H. Mallard - Mallard Tractor Co. - Navasota
Frank Vacante - Smith Brothers Implement Co. - Navasota
William E. Walkoviak - Mallard Tractor Co. - Navasota
Gary Calvert - Schneider Ware Co. - Eagle Lake
Leeland Copeland - Schneider Ware Co. - Eagle Lake
Corvin Frenzel - W. A. Virnau & Sons - Eagle Lake
Draper Stephens - Eagle Lake Implement Co. - Eagle Lake
Riley A. Wiese - Eagle Tractor Co. - Eagle Lake
Jack J. Hansen - Bay Equipment Co. - Bay City
Claude Bunell, Jr. - Elco Implement Co. - El Campo
Eugene Bodugen - Gulf Coast Farm Equipment - El Campo
Emil Linanec - Shult Implement Co. - El Campo
Julius Jankowski - Sealy Tractor & Implement Co. - Sealy
Walter A. Virnau, Jr. - W. A. Virnau & Sons, Inc. - Sealy
D. G. Wendt - Browder Tractor & Implement Co. - East Bernard
E. H. Wozniak - Wharton Tractor Co. - Wharton
Wilton Bailey - Rosenberg
Adolph E. Sebesta - Lamar Tractor Co. - Rosenberg
Marvin E. Wilke - Shult Equipment Co. - Rosenberg
Lester Selig - Farm and Ranch Supply - Needville
Floyd Garner - Montgomery Tractor Co. - Seymour
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Donnie Bramlett - Bramlett Implement Co. - Stephenville
David C. Fulburg - W. B. Sartor and Son - Stephenville
Lynn Kinsey - Bramlett Implement Co. - Stephenville
Juacaine Lindsey - Stephenville
Bill Doty - Doty Bros. Farm Equipment Co. - Abilene
Darrell C. Knight - Doty Bros. Farm Equipment Co. - Abilene
Marvin Bowden - Sartor Bros. Ford Tractor - Comanche
Roy G. Mitchell - Mitchell County Implement - Comanche
E. A. Sartor - Sartor Bros. Ford Tractor - Comanche
Howard G. Baxter - Ken Nichols International - Vernon
Fred M. Byrd - Byrd Implement Co. - Vernon
Floyd Graf - Greenbelt Farm Machinery Co. - Vernon
Johnny Moore - Wilbarger Farm Machinery Co. - Vernon
J. D. Harper - Harper Implement Co. - Goldthwaite
Mrs. Allen Hill - Hill Implement Co. - San Saba
Clauge Guatier - Guatier Truck & Tractor Co. - Hamilton
Lawson Kemp - Brownwood International Harvester Co. - Brownwood
Max Mahan - Mahan Tractor Co. - San Saba
Leon Williams - John Deere Co. - Brownwood
Kenneth Branch - Mahanay International, Inc. - McKinney
Herman Farley - Herman Farley's Auto Repair - McKinney
Harold McMahanay - Mahanay International, Inc. - McKinney
Jim Morgan - McKinney Hardware and Implement Co. - McKinney
Al Rushing - Fry Tractor Co. - McKinney
Herman White - McKinney Hardware and Implement Co. - McKinney
Jim Akin - Terrell
Louis Flores - Terrell Farm Supply - Terrell
Bob Mitchell - Terrell
David Stallings - Stallings Implement Co. - Terrell
Jean Rawson - Rawson Oliver Co. - Sulphur Springs
J. D. Rorie - Rorie Tractor Co. - Sulphur Springs
Jerry Lucy - Taylor Equipment Co. - Longview
Paul Reynolds - Taylor Equipment Co. - Longview
Frank E. Godfrey, Jr. - Russ Davis International, Inc. - Longview
Joe Stephens - Stephens Implement Co. - Henderson
Alton P. Smith - Smith Implement Co. - Paris
R. C. Singer - Bob Singer, Inc. - Paris
William F. Davis - Larue Ford Tractor Co. - Paris
Charles Smith Allen - Allen Farm Store - Paris
Willis L. Compton - Harvey Brothers - Clarksville

Respondents (cont.)

J. W. Gill - Bogata Implement Co. - Bogata
Clyde Harvey - Harvey Brothers - Clarksville
J. P. Johnson - Clarksville
W. R. Hendrix - Hendrix Farm Supply - Tyler
E. G. Brown - E. G. Brown Tractor Co. - Tyler
Leon R. Dominy - George Kidd Tractor Co. - Tyler
George Kidd - George Kidd Tractor Co. - Tyler
Jack Cornish - Hallsville
Frank E. Godfrey - Russ Davis International, Inc. - Longview
B. A. Harrison - Marshall
Edward Bigon - Bigon Implement Co. - Taylor
John Bigon - Bigon Implement Co. - Taylor
James Dvorak - Krieg Bros. Chevrolet Co. - Thrall
Eugene Guinn - Williamson County Equipment Co. - Taylor
Walter Jezek - Taylor
Jerry Tailas - Williamson County Equipment Co. - Taylor
Edwin L. Brown - Brown & Williams Conservation Contractors - Brady
Roger George - George Tractor Co. - Brady
Conley A. Purcell - Vinson Tractor Co. - Brady
August Steelhammer - Farmers Supply - Brady
Trenton Hamrick - Hill Implement Co. - San Saba
Harvy L. Reeves - San Saba Tractor Co. - San Saba
James Gronewald - Hondo Implement Co. - Hondo
Charles L. Neuman - Mumme Truck Sales - Hondo
John H. Strait - Strait Equipment Co. - Hondo
Bruno M. Angermann - Evans Implement Co. - Clifton
Jim Jones - Evans Implement Co. - Clifton
E. V. Stevens - Stevens Motor and Implement Co. - Clifton
E. C. Hines - Hines Supply - Palestine
R. E. Rowland - Farmers Tractor Co. - Palestine
E. H. Shelton - Shelton Implement Co. - Palestine
T. W. Bailey, Jr. - Farmers Implement Co. - Cleburne
Ray Baker - Baker Implement Co. - Cleburne
Luther B. Moseley - Jack Moseley Motors, Inc. - Livingston
Carel Rasberry - Livingston
Bob Reed - Smith Tractor and Implement Co. - Cleveland
Alton Smith - Smith Tractor and Implement Co. - Cleveland
D. A. Bennett, Jr. - Beaumont Equipment Co. - Beaumont
W. D. Hall - International Harvester Co. - Beaumont
Lannie McDaniel - International Harvester Co. - Beaumont
A. A. Richard - Beaumont Equipment Co. - Beaumont
James W. Gober - Nome Supply Co. - Nome

Respondents (cont.)

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John G. Mokry - Oil City Tractors, Inc. - Beaumont
L. C. Tucker - Nome Implement Supply Co. - Nome
Jack Beard - Beard Truck and Implement Co. - Beaumont
Bennett Equipment Co. - Crockett
Jasper Driskell - Driskell Farm Service - Crockett
Arlon Gunnels - Knox Motor and Implement Co. - Crockett
Jed Cryer - Walker County Truck and Tractor - Huntsville
Roy Jordon - Walker County Truck and Tractor - Huntsville
James Hardy Nevill - Madison County Tractor Co. - Madisonville
Leon Wakefield, Jr. - Buddy Wakefield and Sons - Madisonville
Erwin H. Batot - Harlingen
Eddie L. David - Valley Implement Company - Harlingen
M. O. Fletcher - Delta Sales - San Benito
Duane A. Steiner - Aldridge Washmon Co. - San Benito
Richard Walters - Planters Equipment Co. - Harlingen
Gene Kulchak - Kulchak Tractor and Equipment - Alice
Quitman Lindley - Lindley International, Inc. - Alice
Henry F. Valenta - Henry's Equipment Co. - Alice
J. C. Zapalac - Lindley International, Inc. - Alice
Billy Autry - Cage Implement Co. - Taft
Walter W. Childers - Taft Implement Co. - Taft
Tom M. Reding - Taft Implement Co. - Taft
Preston D. McKinny - Taft Implement Co. - Victoria
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John Stockbauer, Jr. - Victoria Farm Equipment Co., Inc. - Victoria

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OPPORTUNITIES AND REQUIREMENTS FOR ENTRY INTO THE AGRICULTURAL MACHINERY MECHANICS TRADE

CHAPTER I

INTRODUCTION

The Problem

The Vocational Education Act of 1963 was signed into law by President Johnson on December 18, 1963. It confirmed the determination of the United States to provide persons of all ages and ability levels with training to qualify them for gainful employment in almost all recognized non-professional occupations. Consequently, states were given authority and financial assistance to improve and expand existing vocational education programs and to establish new ones.

As a result of this legislation, the Texas Education Agency inaugurated, as a part of vocational agriculture, a new program in the school year of 1966-67 entitled "Pre-employment Laboratory Program in Farm Machinery Service and Repair." Persons enrolled in this program are junior and senior secondary students who have expressed a desire to become farm machinery mechanics. All instruction is in the school. Facilities simulate, insofar as possible, those found in commercial establishments.

The intent of this program was to provide training that would enable a young man to enter the mechanics trade and to make satisfactory progress in it. It was soon realized, however, that the "entry level" of the occupation was not known; persons constructing courses of study were confronted with the problem of determining what a beginning mechanic should know and be able to do in order to enter the trade to his satisfaction and to the satisfaction of his employer.

According to the guiding principle of course construction in vocational education, content must be based upon the knowledge and skills needed in the occupation and content needed most should be taught first. In order to implement this principle, a group of persons knowledgeable in the area of farm machinery mechanics met in Austin and formulated an extensive list of competencies needed by mechanics. It was soon learned, however, that the compilation included most of the competencies possessed by master mechanics. Therefore, it became necessary to reduce this list to those units of knowledge and skills that would be most appropriately taught to persons just entering the trade. This investigation was initiated to establish the basic knowledge and skills needed by beginning mechanics.

Another problem involved the availability of information about the mechanics trade. A fundamental principle of vocational guidance is that a wise choice of an occupation is based upon a thorough knowledge of the requirements and opportunities of the occupation in relation to the personal attributes of the individual. A search revealed meager information available to prospective mechanics. Consequently, counselors and teachers were unable to discuss with students the opportunities available in the trade for a career on a short- or long-range basis.

Purpose of the Study

The purposes of this investigation were (1) to determine the content that should be included in courses of study designed to train persons to enter the farm machinery mechanics trade and (2) to obtain information about the occupation that would be useful to persons considering the trade as an occupational goal. More specifically, the objectives to be achieved were:

1. To determine the level of knowledge and skills desired by employers for persons entering the mechanics trade in farm machinery service and repair.

2. To obtain information about the occupation that would serve as a guide in directing the counseling process in relation to the requirements and opportunities for employment in the trade.

Procedure

The collection of data was based upon three assumptions. First, it was assumed that persons employed in the business are capable of identifying the basic knowledge and skills needed by persons entering the occupation. Second, it was assumed that owners or managers would reveal characteristics about the occupation that could be utilized for occupational information purposes. Third, it was assumed that competencies identified by the Vocational Division of the Texas Education Agency in the publication, *Suggested Basic Course Outline for Agricultural Machinery Service and Repair*, were valid.

The administrative aspects for obtaining data involved contributions from many persons--ranging from the State Director to service managers in farm machinery service and repair shops. First the State Director of Agricultural Education requested each of the ten area supervisors of agricultural education to send to him the names of four teachers of vocational agriculture residing in his area that would likely assist with the project.

Criteria for selecting teachers were (a) that they reside in communities that would likely have four dealerships which include service and repair shops and (b) that they had lived in the community long enough to be personally acquainted with farm machinery personnel. This last criterion was considered to be of major importance in establishing rapport with the persons from whom information was to be obtained.

Upon receipt of the names of these individuals, the Director sent to each a letter requesting cooperation in the project and stated that the area supervisor and the investigator would make contacts soon to explain the project and to provide instructions for obtaining data.

The investigator met with the area supervisor at a time and place agreeable to both--usually at the area supervisor's office. The supervisor accompanied the investigator in the process of visiting each teacher to provide forms and instructions for collecting data.

Data for the "knowledge and skills" part of the study were obtained from the manager of the service and repair shop. Data for the "occupational information" phase of the project were obtained from the manager of the business. He may have been the owner or a hired manager. In either case he was responsible for the entire operation of the business.

Items used to assess the entry level of beginning mechanics were taken from a report entitled Suggested Basic Course Outline for Agricultural Machinery Service and Repair, published in 1966 by the Vocational Division of the Texas Education Agency. This publication contained about 2000 competencies identified by a state-wide committee. These were, for the most part, all the competencies that might be possessed by a master mechanic. However, this number was reduced by the investigator, in consultation with persons competent in the area of mechanics, to approximately 1000 items.

The items finally selected, after extensive field testing with mechanics, were rather arbitrarily placed into four interview schedules as follows:

1. Component Parts of Machines, Safety, and Fuels and Lubricants
2. Internal Combustion Engines, Electrical Systems, and Instruments
3. Power Train and Hydraulics
4. Lubricating, Cooling, and Fuel Systems

Each of these four schedules contained approximately 250 items. At the end of each form, a few questions relating to the training of mechanics were included. The last page was blank except for the request for suggestions that might be used in developing programs to train mechanics. Much valuable information was obtained from comments on this page.

Each item was followed by numerals from 1 to 5. The numeral 5 was to be circled only if the respondent was undecided. One of the other numerals was to be circled according to the degree of importance the item was believed to be for a beginning mechanic.

In analyzing responses, a mean score was established for each item. Mean scores were then divided into four categories in descending order of importance: 1.74 and below, 1.75-2.24, 2.25-2.99, 3.-4.

In administering the "knowledge and skills" form, teachers informed the service manager about the purpose of the project and instructed him in the procedure for responding; the forms were then left with him to complete. At a time agreed upon, the completed forms were obtained from the respondent and transmitted to the investigator.

The "occupational information" form was developed upon the premise that guidance information is desirable for persons considering a career in any field of work. Basic information was acquired regarding (a) opportunities for entering the mechanics field, (b) opportunities for advancing in the trade, (c) fringe benefits available, (d) wages, (e) hours worked per week, and (f) miscellaneous information. Data obtained with this form were by interviews made by teachers. A detailed interview guide was developed to provide instructions for the interviewer.

A critical analysis of the administrative procedure used in collecting data seems to justify the conclusion that for this study it was good. It involved many persons who had never had any connection with research. This involvement seems highly desirable because many of the teachers who assisted and all of the supervisors will be consumers of the information obtained.

Furthermore, farm machinery personnel seemed to be highly pleased that persons from the Texas Education Agency and from Texas A&M University wanted their views on what should be taught in school. Many wrote comments expressing a desire to work with schools in developing programs to train mechanics.

One difficulty encountered was in arranging a time schedule. When so many persons are involved, it is difficult to find a time suitable for all. Supervisors and teachers were often involved in activities to the extent that their time available would not mesh with the available time of the investigator.

In some cases the community selected by the supervisor did not have four farm machinery businesses. This, however, was not a serious problem since allowances were made for this possibility in selecting the number of businesses for the sample.

Description of Sample

Two sources of information were used to implement the dual purpose of this study; consequently, a rather wide variation in the number of responses to each part exists. The total number of managers interviewed to collect data for the occupational information part of the study was 51; however, a few failed to provide a response to some items. The total number of service managers providing information for the knowledge and skills phase was 120. These were divided four ways, as previously stated, making a total of approximately 30 responses to each item.

The sample represents responses from all parts of the State as shown in Figure 1. It may be observed that the area close to Texas A&M University contributed a larger share to the study than other parts of the State. Several towns previously selected for responses did not have the four dealerships specified; therefore, additional responses were obtained nearby to conserve travel and time.

Responses for Occupational Information Phase

The mean number of years the 51 businesses had been in operation was 19.49. The range was from 2 to 53 years. The labor force in farm machinery businesses, as shown in Table 1, is composed of slightly more than 35 percent mechanics, with partsmen representing the second largest percentage. The mean number of mechanics was 3.79 per business. A variety of job classifications was included in "other," such as bookkeepers, secretaries, and machinery set-up men.

The actual distribution of the labor force by businesses varies somewhat from that shown in Table 1. Table 2 shows the percentages of businesses that classify persons by the job titles listed. It should be noted that all businesses employ mechanics, but only slightly more than 88 percent have persons classified as salesmen. Of special interest to this study was that only 70.59 percent of the firms employ mechanics' helpers.

Approximately one-fourth do not have service managers. Evidently, this situation exists in small businesses; the duties normally done by service managers are performed by a mechanic or the manager of the firm.

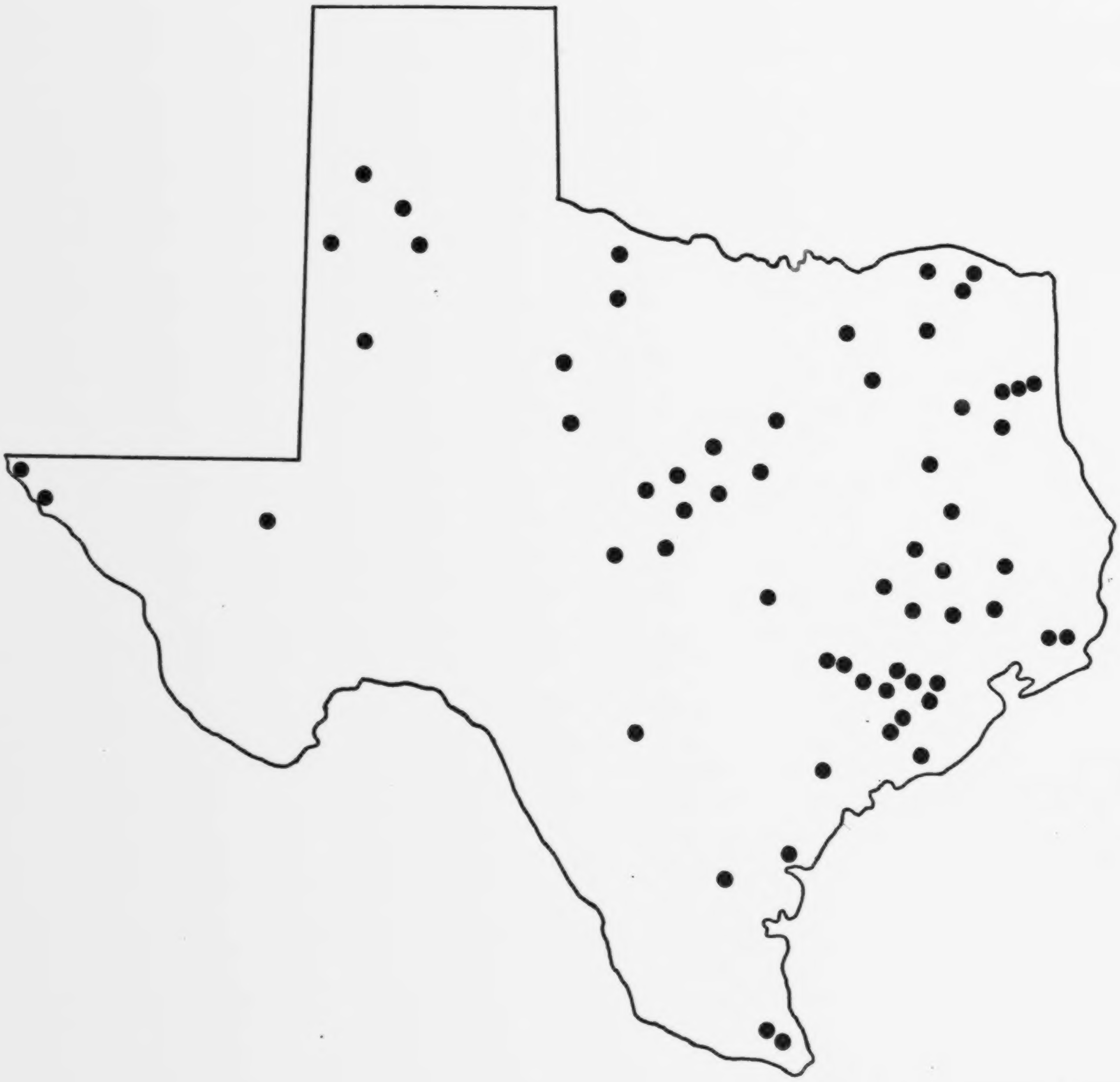

Figure 1

Location of Businesses Furnishing Data for this Study

Table 1

Mean Number and Percentage Distribution of Persons by Job Classification in Businesses Providing Responses for This Study*

Job Classification	Mean	Percent
Mechanics	3.79	35.77
Mechanics' Helpers	2.22	14.23
Partsmen	1.80	15.66
Salesmen	1.80	14.41
Other	1.70	6.94
Porters	1.58	5.34
Service Managers	1.08	7.65
	TOTAL	100.00

*Calculated on the basis of businesses having employees in these job classifications.

Table 2

Number and Percentage of Businesses Having Employees by Job Classifications

Job Classification	Number of Businesses	Percent*
Mechanics	51	100.00
Partsmen	49	96.08
Salesmen	45	88.24
Service Managers	40	78.43
Mechanics' Helpers	36	70.59
Other	23	45.10
Porters	19	37.25

*51 businesses responded

John Deere and International Harvester dealerships contributed slightly more than 50 percent of the responses in this investigation, as shown in Table 3. Almost 20 percent were classified as "other." These constituted a combination of equipment brands, including some trucks.

Table 3

Distribution of Types of Dealerships Furnishing Responses for the Occupational Information Phase of the Investigation

Dealership	Number of Businesses	Percent
John Deere	13	25.49
International Harvester	13	25.49
Ford	7	13.72
Massey-Ferguson	6	11.76
J. I. Case	2	3.92
Other	10	19.62
TOTAL	51	100.00

Responses for Knowledge and Skills Phase

The mean number of years service managers had been in their present position was 11.76. The range was from 1 to 35 years. The mean number of years they were employed by the present firm was 11.23 with a range from 1 to 30. The mean number of shop employees, including all classifications, was 4.41. Only 45.37 percent, however, reported part-time employees.

The distribution of the 120 dealerships providing information for this phase of the study shows, Table 4, that John Deere and International Harvester contributed almost 50 percent of the responses. A comparison of Tables 3 and 4 would cause one to suspect that the distribution shown parallels the actual distribution among firms in the State selling the different brands.

Table 4

Distribution of Types of Dealerships Furnishing Responses for the Knowledge and Skills Phase of the Investigation

Dealership		Number of Businesses	Percent
John Deere		28	23.33
International Harvester		25	20.83
Ford		15	12.50
Massey-Ferguson		12	10.00
J. I. Case		7	5.83
Allis-Chalmers		4	3.33
Oliver		3	2.50
Minneapolis-Moline		1	0.85
Other		25	20.83
	TOTAL	120	100.00

Definition of Terms

Certain words and terms used in this report need to be defined in accordance with the way they are used.

Beginning Mechanic. A beginning mechanic is a person who has had basic training in mechanics at high school before he is employed. He may be known in the trade as a mechanic's helper.

Knowledge. Knowledge is an understanding of the function of a mechanical unit and its relationship to the functioning of other units.

Skills. Skills are those manipulative activities performed in servicing or repairing mechanical units.

Service Manager. Service manager is the person responsible for the service and repair shop in a farm machinery company. He may also be known as the head mechanic, lead mechanic, or shop foreman.

Manager. Manager is the person responsible for the entire farm machinery business. He may own the business or manage it for the owner.

CHAPTER II

OPPORTUNITIES IN THE FARM MACHINERY MECHANICS TRADE

Introduction

The chapter will present the opportunities available to employees in the farm equipment mechanics trade. It is somewhat difficult, however, to make a clear distinction between an opportunity provided in the business and a requirement for employment. The position taken, therefore, was to assume that opportunities are always cast into the framework of requirements within the occupation. Consequently, the length of the workweek, personal attributes, and the like are included in this chapter as opportunities even though employers may require them as conditions for employment.

Presentation of Data

Need for Mechanics

Obviously, there is an extreme shortage of well-qualified farm machinery service and repair mechanics. Eighty-eight percent of the respondents in this study reported mechanics as their greatest need for well-qualified workers as shown in Table 5. Another 6 percent listed mechanics as the second greatest need. Therefore, it appears that approximately 94 percent of the farm machinery businesses experience a shortage of well-qualified mechanics.

Fifty-eight percent of those responding listed partsmen as the second greatest need; 4 percent listed them as the greatest. Therefore, 62 percent of the respondents experience a shortage of qualified parts personnel.

Table 5

Number of Businesses Stating First and Second Needs for Employees by Job Classification*

Job Classification	Level of Need First Need Number	 Percent	 Second Need Number	 Percent
Mechanics	44	88.00	3	6.00
Partsmen	2	4.00	29	58.00
Salesmen	2	4.00	9	18.00
Service Managers	2	4.00	3	6.00
Mechanics' Helpers	0	0.00	2	4.00
Porters	0	0.00	0	0.00
Other	0	0.00	4	8.00
TOTAL	50	100.00	50	100.00

*Only 50 businesses provided this information.

Salesmen were listed in short supply by some 22 percent of those responding. They were listed by 4 percent of the respondents as the greatest shortage and as the second greatest shortage by 18 percent.

The critical nature of the shortage of mechanics may be shown best by the numbers needed. In the sample taken, the mean number per business needed at the time of the study was 2.16. There were 928 farm machinery businesses in Texas, according to the executive secretary of the Texas Hardware and Implement Association. Therefore, the actual number needed to fill present requirements was 2,000, Table 6. An additional 1,568 will be needed "within the next

Table 6

Approximate Number of Employees Needed in Texas as Mechanics and Partsmen Now, Within 12 Months, Within 5 Years

	Job Classification	
Time	Mechanics	Partsmen
Now	2,000	860
Within 12 Months	1,568	835
Within 5 Years	3,866	1,949
TOTAL	7,434	3,644

12 months," with an additional 3,866 needed "within the next 5 years." Consequently, the total estimated number of mechanics needed within the next five years will be slightly more than 7,000. The need for programs for training mechanics was expressed well by a manager who stated:

> In these times when machines are getting more expensive and more technical all the time and so few young men are pursuing this field of training, we desperately need a source of young men who are intelligent and who have . . . a basic knowledge of mechanics so that we have replacements for older men who are retiring or who cannot keep up with technical advances which are being made in farm equipment.

Likewise the critical nature of the shortage of partsmen can be shown by the numbers needed. At the time of the study, there was a "present" need for 860, Table 6. An additional 835 was the estimated need "within the next 12 months," with an additional need for 1,949 "within the next 5 years." Consequently, the total estimated number of well-qualified partsmen needed within the next five years is slightly more than 3,600.

Desire to See Mechanics Training Program in High Schools

In response to the question, "Would you like to see local high schools develop programs to train mechanics?" 94.11 percent answered affirmatively and 5.89 percent were undecided, Table 7. Of those answering in the affirmative, 87.76 percent stated that they would furnish equipment; 87.76 percent would furnish bulletins and manuals, films, and other teacher aids; and 93.88 percent would furnish technical assistance from employees, Table 8.

Table 7

Attitude of Managers Toward the Development of Programs for Training Farm Machinery Mechanics by Local High Schools

Attitude		Number	Percent
Yes		48	94.11
No		0	0.00
Undecided		3	5.89
	TOTAL	51	100.00

A few comments from managers follow to emphasize their willingness to assist schools in developing programs for training mechanics:

> "There is a need for vocational training for the large number of high school students who cannot and will not enroll in college of in special training after graduation from high school."
>
> "We would be more than willing to help in any way that we believe would be of benefit to students."
>
> "Needed badly"

"Any assistance needed"

"We would be more than glad to help the school develop a training program in hopes we could hire some of the boys after they have completed their training."

Table 8

Willingness of Managers to Furnish Assistance to Local High Schools with Programs for Training Mechanics

Assistance	Yes		No		Undecided	
	Number	Percent	Number	Percent	Number	Percent
Equipment	43	87.76	1	2.04	5	10.20
Films, technical bulletins, etc.	43	87.76	0	0.00	6	12.24
Technical advice	46	93.88	0	0.00	3	6.12

Willingness to Teach Young Man to Be a Mechanic

Service managers were asked if they would be willing to teach a young man on the job to become a mechanic. Almost 78 percent of those responding, Table 9, stated that they would. However, 22 percent of the respondents were undecided. Only one stated that he would not be willing. Many of those that were undecided qualified their answers by stating, "It would be the decision of management." Others qualified their answers by such statements as, "It depends on the amount of time available," and "It takes a lot of time."

Table 9

Willingness of Service Managers to Teach a Young Man on the Job to Be a Mechanic

Willingness		Number	Percent
Yes		91	77.12
No		1	0.85
Undecided		26	22.03
	TOTAL	118	100.00

Length of Time to Become a Mechanic

Estimates as to the length of time required for a beginning mechanic to become a mechanic ranged from one to five years with the mean being about 2.5 years. As would be expected, almost 100 percent of the answers were qualified. These qualifications fell into two major categories--"desire" and "aptitude." Other personal characteristics mentioned frequently were attitude, personality, and ability to cooperate with management and other employees.

Wages and Workweek

Evidently, the shortage of mechanics is aggravated by low wages and the long number of hours required to work each week. The average workweek was 47.98 hours with an average weekly wage of $119.65, or approximately $2.50 per hour. The range for the workweek was from 44 to 54 hours. The wages ranged from $80 to $200 per week. The average weekly wage for a beginning mechanic was $73.53, or approximately $1.50 per hour. The weekly range was from $50 to $100.

Evidently, wages vary among mechanics within most businesses. Some apparently are paid on a "flat rate" per job order; others are on a straight hourly basis. Skill and experience seem to be the two major factors that influence wages earned. However, such comments as "personality" and "cooperation with other employees" seem to indicate that factors other than skill and experience are considerations in establishing wages for an employee.

One manager expressed optimism about wages when he stated, "There is a great shortage of skilled mechanics, especially in repair of farm equipment. Pay scale for all mechanics is below that of plumbers and masons, but pay rates for mechanics are expected to increase more than any other category of skilled workmen."

In response to the question as to what reason mechanics give for quitting to take another job, 89 percent stated "higher wages." There was little evidence that the long workweek was a major reason for quitting, even though this factor was mentioned in several cases.

The number of mechanics "fired" is evidently rather small. There was some evidence, however, that incompetent mechanics were employed because of the extreme shortage. Of those that were dismissed, three main reasons were given; namely, lack of interest, poor attitude, and lack of skill.

It is rather obvious that the greatest labor turnover within farm machinery businesses is among mechanics. Eighty percent of replacement personnel hired "during the past year" were mechanics; mechanics' helpers was the next greatest category of turnovers.

Age for Hiring Mechanics

The minimum age for hiring mechanics seems to be 18; however, the mean age given was 19.22. Evidently, the minimum age requirement is influenced by law and by a desire for as much maturity as possible. One is likely to associate the age of 18 with graduation from high school; however, almost 50 percent of the managers refused to state a minimum level of formal education for hiring mechanics. Therefore, one is forced to conclude that, in general, employers are not concerned about the formal educational achievements of mechanics.

The maximum age for hiring mechanics was within the range of 55-60. However, many respondents refused to give an age that they would consider maximum; they preferred to consider the health and experience of the individual.

In considering responses regarding the age and educational requirements for mechanics, it must be kept in mind that respondents were reacting in light of a severe shortage of qualified workers. One can only speculate as to the requirements that might exist under a more favorable labor market. It is unlikely that age requirements would change, but there seems to be a high probability that minimum requirements for formal education would be high school.

Opportunities for On-the-Job Training

Opportunities are available locally for on-the-job training of mechanics in approximately 89 percent of the dealerships included in this study. However, the nature of these programs seems to be quite variable. Evidently, the common purpose of local training programs is to keep mechanics up-to-date on model changes and to acquaint them with new technical bulletins and manuals. However, some businesses use films, records, and questionnaires supplied by the factory. Classes are held at night. There is no evidence in this study, however, that warrants the belief that local businesses sponsor programs of any kind to train unskilled persons to become efficient mechanics.

There was, however, enough evidence to cause the investigator to suspect that more and better training programs are desired by employers. Some stated rather emphatically that a lack of effective local training programs was among the biggest problems facing most dealers.

All local dealerships send one or more mechanics to district or area training sessions sponsored by factory representatives. The primary purpose of these sessions is to upgrade local personnel in the adjustment and operation of new farm machinery or in model changes. Expenses and wages are paid during attendance by local dealers. The amount of time varies from one day to a week depending, of course, on the nature of what is being taught. Evidently, the mechanics who attend regional or district schools assume responsibility for upgrading fellow employees as indicated in the statement, "One mechanic attends factory courses and then passes on training to other mechanics during night get-togethers."

In spite of local and district training programs being directed toward upgrading skilled personnel, the beginning mechanic has three excellent means of becoming a skilled person. First, he will be assigned to work with a master mechanic; second, he will participate in local training programs and perhaps be sent to district schools; and third, he can read and study technical books and manuals at night. This third means was repeatedly emphasized as the best way to become a good mechanic in the shortest possible time.

Fringe Benefits

Most employers in this study allow paid vacations for employees. The amount of time varies, in most cases, with length of service. The most common arrangement seems to be about one week for employees with less than three years of service, then two weeks. A few, however, stated that they allow mechanics to take vacation time but without pay. This seems to be an extreme variation from the common practice.

Most dealerships have sick leave arrangements which provide benefits for employees. Apparently, some employers pay full wages; others seem to pay approximately 75 percent of regular wages. In some cases salaried personnel receive sick leave benefits, but hourly wage earners do not. The most common amount of time allowed for paid sick leave is one week. Some allow time to accumulate; but, apparently, many do not.

Almost all farm machinery dealerships have some type of insurance program with joint participation between employee and employer. A rather common arrangement is for the firm to pay the cost of hospital insurance for the employee, with the employee paying the cost for the members of his family. Some companies share the cost of life insurance with employees.

Evidently, most employers carry sickness and accident insurance for employees. This seems to be the primary means of providing sick leave benefits, especially for cases lasting for extended periods.

Farm or Ranch Background Preferred

Managers were asked their preferences regarding the background of a beginning mechanic. Seventy percent favored a farm or ranch background; 30 percent had no preference. None preferred a person reared in town. It is evident that rural boys who desire to become farm machinery service and repair mechanics have a decided advantage over persons with little or no farm or ranch experience.

One Factor Believed to Be Most Important in Becoming a Competent Mechanic

Managers were asked to state the factor that they believed was most important in a person becoming a competent mechanic. The two most frequent responses were "desire" and "aptitude." However, other factors such as "interest," "common sense," "intelligence," and "pride in workmanship" were mentioned.

One service manager summarized the requirements for being a successful mechanic in the following statement:

Here are a few things I think a man must have before he can be a successful mechanic:

> (1) He must be interested in mechanics work. He must know the hardships involved and be able to cope with them.
>
> (2) After interest comes capability. He must be able to comprehend and develop the skill of mechanics.
>
> (3) He must be of good nature to mix well with customers.

Work Habits

A great deal of concern was expressed about the work habits of mechanics, including pride in workmanship, respect for tools, and cleanliness of work areas and of themselves. The following two quotations from service managers express the concern rather well:

> "Many mechanics do not keep their work areas clean. They should take old parts to the scrap pile to keep them from getting mixed up with the new parts they plan to install in the unit they are repairing. Also, if these old parts are out of the way, it will give the mechanics more work room and save time in separating parts."
>
> ". . . I suggest the young mechanic learn to work clean, have his repair parts clean, and his tools and tool box or trays clean. He should always put tools back in their respective places when the job is finished. Never leave them scattered all over the floor. We all know that when a customer comes to the shop to have some work done, he looks at the mechanic; and if he sees that he is clean, his tools are clean, and his bench is clean, he says to himself, 'Now I know I am going to get a good job done here.' As a rule, he is. Another thing, the beginning mechanic should learn to do as the master mechanic tells him. He should be nice to him and it will be a pleasure for the master mechanic to work with the young mechanic. I suggest that is the best and quickest way to become a good mechanic."

CHAPTER III

REQUIREMENTS FOR BEGINNING MECHANICS IN THE FARM MACHINERY MECHANICS TRADE

Introduction

The primary purpose of this chapter is to present data that sets forth the requirements of the occupation for a beginning mechanic in terms of what he should know and be able to do to successfully enter the trade and make satisfactory progress in it. The first portion of the chapter will present rather general information; the latter part will present findings relative to specific knowledge and skills as they apply to mechanical units.

In keeping with the purpose of this study, all data are presented and treated in a way believed to be most appropriate to the development of courses of study for training young men who plan to become tradesmen. Consequently, tables pertaining to mechanical knowledge and skills are teaching-oriented in terms of course content; only first and second priorities are given. Therefore, many items included in the study were eliminated.

General Requirements

Safety

Developing safe work habits should be the first order of business in any program designed to train for occupational competence. One service manager stated the importance of safety when he said, "Safety is always the first thing a mechanic should learn. Even though a man may be a good mechanic, one accident may be fatal. Safety is considered his first interest; next he must be interested in his job."

Table 10 shows the items listed in the schedule. It is worthy of note that every item is ranked as number one in importance. It may be observed that all items were listed under knowledge because it is believed that safe work habits result from an understanding of the cause of accidents. Therefore, persons responsible for directing the activities of others should be alert to create safety awareness. One service manager pointed this out when he stated, "Safety should be stressed at all times and is equally important to all subjects." Another stated, "Teach safety--proper handling of tools, stands, jacks, etc.; also fire hazards, grease on floors, parts and tools lying around in walkways."

Knowledge and Skills Relative to Tools

The group of items ranked second in importance in this study is the knowledge and skills relating to tools. One respondent stated the matter rather well when he said, "The use of tools is the mechanic's bread and butter. Therefore, the first thing he must learn is to use his tools properly and quickly; otherwise he won't eat very well in this trade."

Table 11 shows the order in which items are ranked in importance. The most important tool, in terms of its mean, is the operator's manual and the second is technical bulletins and service manuals. Evidently, one could safely conclude that a mechanic to be successful, must be able to read well and to

Table 10

Priority for Teaching Safety

Knowledge by Priority Levels*

KNOWLEDGE--First Priority

- Understand personal safety (protective clothing, eye safety, cleanliness, etc.)
- Understand the safe use of tools and equipment
- Understand farm equipment safety around shop
- Understand proper methods of lifting and carrying
- Understand battery and electrical system safety
- Understand the safe use of cleaning materials
- Understand the dangers of fuel fires, hot engine coolants, lifting devices, presses, and compressed air
- Understand the types and uses of fire extinguishers
- Understand proper methods of ventilation in the shop
- Understand need for safety shields on power take-off, gears, etc.
- Understand nature of safety rims on wheels
- Understand safety precautions involved in working with gasoline fuel tanks
- Understand the danger involved in working with LP gas tanks

---

*All safety items were assigned a first priority rating. There were no safety skills listed on schedule.

Table 11

Priority for Teaching Knowledge and Skills Relative to Tools

Knowledge and Skills by Priority Levels*
KNOWLEDGE--First Priority
Understand the use of the different kinds of hand tools
Understand the different types of hand tools
Understand the function of different kinds of power tools
SKILLS--First Priority
Be able to interpret operator's manual
Be able to interpret service manual and technical bulletins
Be able to use hand tools properly
Be able to use torque wrenches
Be able to use proper tool nomenclature
Be able to use compression tester
Be able to use timing light
Be able to use power tools
Be able to use vacuum gauge
Be able to use electrical testers
Be able to use tachometer

Table 11 (cont.)

SKILLS--Second Priority

Be able to use micrometers

Be able to use dynamometer

---

*No second priority assigned to knowledge about tools.

follow written instructions. Only two items, micrometers and dynamometers, are given a second priority rating.

Ownership of Tools

Service managers were asked if a beginning mechanic should own a basic set of hand tools. Table 12 shows that 86.67 percent responded affirmatively,

Table 12

Opinions as to Whether a Beginning Mechanic (Mechanic's Helper) Should Own a Basic Set of Hand Tools

Opinion		Number	Percent
Yes		104	86.67
No		12	10.00
Undecided		4	3.33
	TOTAL	120	100.00

10 percent negatively, and only 3.33 percent were undecided. Therefore, it can be concluded that persons entering the trade should own a basic set of tools. A set suitable for a beginning tradesman would cost about $50, according to one service manager, and can usually be purchased through the payroll deduction plan.

Apparently, the ownership of tools has more psychological than real value as indicated by the following statements from service managers:

> A beginning mechanic would not necessarily need a set of tools to begin with. At first it is better to team him up with a mechanic who would have the ability to teach him the trade and let him use his tools in exchange for the help the mechanic would receive from the beginner. Tools can then be purchased gradually as the need arises.
>
> A man should know and appreciate the value of tools and equipment. Personal ownership encourages competence where tools are concerned.
>
> I judge a man's pride in his work by the way he keeps and takes care of his tools. If he knows what he has and where they are, with study and experience someday he may be called a mechanic.
>
> I feel that a helper should buy a good set of tools. This would show a service manager that he is interested. A good mechanic doesn't loan his tools, and a shop doesn't furnish hand tools . . . .
>
> If he owns his own hand tools, he will take better care of them and learn to use them more effectively.

It is evident from the above statements that the values of ownership and workmanship are associated within the trade with the care and use of tools.

Assembly of New Farm Implements

Service managers were asked if beginning mechanics should be able to assemble new farm implements. Table 13 shows that almost 75 percent responded affirmatively; only one was undecided. The high number of affirmative responses to this item seem rather unusual in light of the number of statements made as qualifications. A few samples follow:

> Setting-up instructions for each machine are thorough enough to preclude this prior knowledge.
>
> Should be able to follow assembly instructions
>
> He can learn to do this if he has aptitude and can read and follow printed instructions.
>
> This is taught by a service school and changes each year.
>
> With any mechanical talent he can take a book and assemble it.

Table 13

Should a Beginning Farm Machinery Mechanic
Be Able to Assemble New Farm Implements

Response		Number	Percent
Yes		87	73.73
No		30	25.42
Undecided		1	0.85
	TOTAL	118	100.00

Two things seem evident from the above statements. One is that the assembly of new farm implements is not considered to be difficult. The other is the emphasis placed on reading and following written instructions. Herein lies one application of the importance of reading for the mechanic. Evidence seems to indicate that the assembly of new implements can be done by persons with adequate aptitude to be a mechanic. No training program seems to be considered necessary.

Adjusting New Farm Implements

Respondents were asked if a beginning mechanic should be able to adjust new farm implements. Slightly more than 51 percent responded negatively; less than 5 percent were undecided, Table 14.

Table 14

Should a Beginning Mechanic Be Able to Adjust New Implements

Response	Number	Percent
Yes	53	44.54
No	61	50.26
Undecided	5	4.20
TOTAL	119	100.00

It is difficult to interpret the responses to this item. Evidently, the adjustments are not considered difficult; therefore, a few comments on the question seem to shed some light on the problem of interpretation.

> This would be almost impossible as it takes field experience on each make and type of implement.
>
> Some new implements require the skilled mechanic who has been trained for these adjustments.

He can obtain adjusting instructions from setting-up manual.

The sooner he can learn, the better mechanic he will make.

There is ample evidence in this study to suspect that mechanics do not consider working on implements to be the proper work of mechanics. In fact the trade does not classify set-up men as mechanics. The following statement made by a service manager seems to indicate that some thought is now being given to specialization:

> In the near future, dealers will have a specific crew for this (implements) department. A mechanic's skills will be more specialized.

Preference for Skills or Knowledge

Service managers were asked which of the following they would prefer a beginning mechanic to have: (a) a large amount of technical knowledge and few skills or (b) a large number of skills and a small amount of technical knowledge. The responses, Table 15, show a rather even distribution between the two choices. Evidently, the two--technical knowledge and skills--complement each other to such an extent that a person without an adequate amount of both would not be a successful tradesman.

It may be observed, however, that responses favor slightly the knowledge item. A comparison of the mean for all items in the four interview schedules pertaining specifically to knowledge with those pertaining specifically to skills shows a substantial difference in favor of knowledge. The mean for knowledge is 1.84 and for skills 2.12 (the smaller number indicates a higher level of

Table 15

Preference for Knowledge or Skills

Choice		Number	Percent
Large amount of technical knowledge and few skills		56	47.06
Large number of skills and small amount of technical knowledge		49	41.18
Undecided		14	11.76
	TOTAL	119	100.00

importance). The design of the study did not permit a statistical analysis; however, the difference causes one to suspect that service managers place greater emphasis on understanding the function of units and unit relationships than on specialized skills in repairing units for beginning mechanics. Regardless, it seems certain that any program designed to train mechanics must maintain a good balance between the knowing and doing phases of training. One service manager summed up this question this way:

> The beginner needs to know what a specific item is doing, why it is doing it, and how it is being done. When a man knows this, proficiency in doing repair work comes easier.

A general observation should be made at this point regarding the nature of the work of mechanics. One service manager remarked, "Technical knowledge is almost as important as skill, but the employer is buying skill and time . . . ."

The mechanic, on the other hand, is selling skill and time as indicated by the following remark, "If I can't beat the clock, I can't make a living in this trade."

One would suspect that mechanics would want to help a young man become a mechanic but cannot afford to spend time helping him; to do so would decrease their earning power. Consequently, the beginner who possesses a high degree of knowledge and the ability to perform many skills will most likely receive the greatest amount of assistance from master mechanics.

Order for Organizing Instructional Units

Service managers were asked to give the order in which they believed the major mechanical areas should be taught to beginning mechanics. Table 16

Table 16

The Order Recommended by Service Managers for Teaching the Various Mechanical Areas

Mechanical Areas	Mean Weight
Engines and Ignition	2.46
Component Parts of Machines	2.97
Lubrication and Fuel Systems	3.28
Electrical Systems and Instruments	4.03
Power Train	4.11
Hydraulics	4.16

shows the order recommended. The interview schedule was divided into four parts, as previously stated; therefore, each respondent ranked these items without full benefit of seeing what each category included. Consequently, there may not have been a clear understanding of all that was included in each area.

It should be noted that engines and ignition are ranked first, followed rather closely by component parts of machines in second place. Table 17 shows the number and percent that ranked the item from one to six. A much higher percentage ranked component parts of machines as number one, but almost 21 percent ranked the area number six. This may indicate that many did not know what was meant by the area and, consequently, marked it last. However, an examination of the forms including the items on component parts of machines shows these persons also ranked engines as the first mechanical area that should be taught. Because of the basic nature of the items recommended at first and second levels of importance, this report will include component parts of machines first under the heading of "Specific Knowledge and Skills Relating to Mechanical Units."

Regardless of why mechanical areas were ranked as they were, the engine seems to be considered the most important area by many mechanics as shown by the following comments:

> I feel the training on the internal (combustion) motor (engine) has been completely overlooked and should be taught to any student. The hydraulic systems should certainly be taught along with other phases of your program. The electrical systems are also an important phase of our service.

Table 17

Number and Percent Assigning Mechanical Areas by Rank

Mechanical Areas	Rank											
	One		Two		Three		Four		Five		Six	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Engines and Ignition	28	26.67	34	32.38	22	20.95	13	12.38	4	3.81	4	3.81
Component Parts of Machines	40	38.10	16	15.24	10	9.52	7	6.67	10	9.52	22	20.95
Lubrication and Fuel Systems	30	28.57	18	17.14	8	7.62	13	12.38	14	13.34	22	20.95
Electrical Systems and Instruments	1	0.95	13	12.38	22	20.95	31	29.53	22	20.95	16	15.24
Power Train	1	0.95	12	11.43	26	24.76	17	16.19	33	31.43	16	15.24
Hydraulics	5	4.76	12	11.43	16	15.24	25	23.81	22	20.95	25	23.81

> I feel that the most important part of a tractor is the engine. A student should have a basic knowledge of it first; but while he is learning this, he should learn all he can about safety in fuel, use of jacks, hoists, stands, etc. Next he should have much training in electrical systems such as batteries, generators, starters, points, condensers, and spark plugs. Most all maintenance is in this area. The transmission and rear end are very important, but they don't require much attention. Hydraulics on any tractor are very technical and will require a lot of study. Air cleaners are probably the most important part of a diesel engine as far as maintenance is concerned. Of course, fuel must be kept clean.

Specific Knowledge and Skills Relating to Mechanical Units

The following portion of this chapter will be presented, for the most part, by use of tables that deal with specific mechanical units. Tables are course content oriented in that they present only the knowledge and skills that should be given first and second priority in the teaching process for developing beginning mechanics. This procedure is not intended to restrict the inclusion of additional content in courses of study. It is, however, intended to emphasize what has been found to be the most important content that should be taught.

Component Parts of Machines

Service managers recommended that this mechanical area be considered secondary to teaching engines. However, by their nature many of the items seem rather basic to an understanding of mechanical units and their functions.

Power Transmission. Beginning mechanics should understand, on a first priority basis, the principles of power transmission and the function of the different types of clutches, Table 18. Secondarily, they should understand the various uses made of the different types of clutches, uses of flexible shafts,

Table 18

Priority for Teaching Knowledge Relative to Mechanical Power Transmission (general)

Knowledge by Priority Levels
KNOWLEDGE--First Priority
Understand the principles of power transmission
Understand the function of clutches
Understand the different types of clutches
Understand the function of universal joints
KNOWLEDGE--Second Priority
Understand uses made of the different types of clutches
Understand the uses of universal joints
Understand the uses of flexible shafts
Understand characteristics of V-belts
Understand different uses of belt drives
Understand functions of chain drives
Understand operation and uses of differential gear units

characteristics of belts, uses of belt drives, functions of chain drives, and the operation and uses of differential gear units. They should also understand the nature and uses of universal joints.

Bearings and Seals. Knowledge about bearings and bearing seals, on a first priority basis, for beginning mechanics includes the function of bearings, the different types and uses of bearings, the causes of bearing failure, and the need for bearing seals and closures, Table 19. Of secondary importance is an understanding of the characteristics of bushings, uses of plain bearings, and construction of bearing seals and closures.

Table 19

Priority for Teaching Knowledge Relative to Bearings and Bearing Seals

Knowledge by Priority Levels
KNOWLEDGE--First Priority
Understand the function of bearings
Understand the different types of thrust bearings
Understand the various uses of thrust bearings
Understand the causes of bearing failure
Understand the function of anti-friction bearings
Understand the need for bearing seals and closures
KNOWLEDGE--Second Priority
Understand the characteristics of bushings
Understand the uses of plain bearings

2

Table 19 (cont.)

KNOWLEDGE--Second Priority (cont.)

Understand the construction of friction or contact-type bearing seals

Understand the construction of slingers or flingers to protect bearings

Understand the construction of labyrinth or clearance-type bearing seals

Gears. Beginning tradesmen should, as first priority, understand the cause of gear failure and the function of gears, Table 20. As a second priority, they should understand the characteristics of gear tooth wear, the different types of gears, the nature and uses of different gear arrangements, and the uses made of different gears.

Engines and Ignition Systems

This mechanical area includes knowledge and skills relating generally to internal combustion engines and specifically to valve mechanisms, piston and connecting rod assemblies, cylinder heads, crankshaft and flywheel assemblies, engine blocks, ignition systems, batteries, cooling systems, and governors. These units and assemblies were grouped together because they all seem to be more closely related to the engine than to any other unit under study.

In developing a course of study, the most important area in which persons who aspire to be mechanics should gain competence is the engine. The engine

Table 20

Priority for Teaching Knowledge Relative to Gears and Gear Drives

Knowledge by Priority Levels
KNOWLEDGE--First Priority
Understand the cause of gear failure
Understand the function of gears
KNOWLEDGE--Second Priority
Understand the characteristics of gear tooth wear
Understand the different types of gears
Understand the nature of different gear arrangements
Understand the uses of different gear arrangements
Understand the uses made of different gears

and units related to it cause the most problems, according to service managers. Therefore, other mechanical areas should not be included in a training program until a satisfactory level of competence has been achieved in understanding engines and in the development of skills in the disassembly and assembly of engines and related units.

Engines (general). Beginning mechanics should, according to tradesmen, have a thorough understanding of the principles of internal combustion as it applies to all types of engines. They should be able to understand the basic parts of an engine and be able to assemble the parts once the engine has been disassembled, Table 21.

Table 21

Priority for Teaching Knowledge and Skills
Relative to Internal Combustion Engines

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand principles of internal combustion
Understand operation of four-stroke cycle engine
Understand operation of two-stroke engines
Understand operation of multi-cylinder engines
Understand the principles of diesel engine operation
Understand basic parts of internal combustion engine
SKILLS--First Priority
Be able to assemble internal combustion engine
SKILLS--Second Priority
Be able to disassemble internal combustion engine

*All items assigned first priority

Valve Mechanisms. It is recommended that beginning mechanics have a thorough understanding of the nature and function of valves and valve mechanisms, Table 22. The most important skills are to set tappets and check for faulty valves. Of secondary importance is the ability to remove and install the various parts of valve mechanisms.

Table 22

Priority for Teaching Knowledge and Skills
Relative to Valve Mechanisms

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand purpose of valves
Understand purpose of tappet clearance
Understand nature of valve timing assembly
Understand causes of valve trouble
Understand nature of valve seats
Understand order of valve arrangement
KNOWLEDGE--Second Priority
Understand how valve rotators operate
Understand nature of cam followers or lifters
Understand causes of wear in valve mechanism
Understand nature of rocker arm assembly

Table 22 (cont.)

SKILLS--First Priority

Be able to set tappets

Be able to check engine to determine if valves are faulty

SKILLS--Second Priority

Be able to remove valve timing assembly

Be able to install rocker arm assembly

Be able to inspect and replace valve assembly

Be able to remove valve assembly

Be able to remove rocker arm assembly

Be able to replace parts of valve timing assembly

Piston and Connecting Rod Assemblies. Beginning tradesmen should understand the function and nature of the piston and connecting rod assemblies, Table 23. Of secondary importance is an understanding of the different types of piston rings. There are no first priority skills; but of secondary importance is the disassembly, replacement of parts, and the installation of piston and connecting rod assemblies.

Cylinder Heads. Of major importance to beginners is an understanding of the function of cylinder heads, why they leak, and the causes of warping, Table 24. First priority skills are the abilities to clean and to install cylinder heads.

Table 23

Priority for Teaching Knowledge and Skills Relative to Piston and Connecting Rod Assembly

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand function of piston and connecting rod assembly
Understand process of "breaking in" piston rings
Understand purpose of piston ring gap
Understand causes of piston ring wear
KNOWLEDGE--Second Priority
Understand function of different types of piston rings
SKILLS--Second Priority*
Be able to remove piston and connecting rod assembly
Be able to disassemble piston and connecting rod assembly
Be able to inspect and replace parts of piston and connecting rod assembly
Be able to install piston and connecting rod assembly

*All items were assigned second priority.

Table 24

Priority for Teaching Knowledge and Skills Relative to Cylinder Heads

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand function of cylinder head
Understand cause of cylinder head leaks
Understand cause of cylinder head warping
SKILLS--First Priority
Be able to clean cylinder head
Be able to install cylinder head
SKILLS--Second Priority
Be able to remove cylinder head
Be able to inspect cylinder head for damage
Be able to check cylinder head for leaks

*All items assigned first priority.

Secondary skills include removal of, inspection for damage of, and detecting leaks in cylinder heads.

Manifolds. To understand the function of manifolds and why they warp and leak are the first and second priorities for knowledge, Table 25. Skills include removal, cleaning, installing, and checking for leaks.

Table 25

Priority for Teaching Knowledge
and Skills Relative to Manifolds

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand function of manifolds
KNOWLEDGE--Second Priority
Understand causes of manifold leaks
Understand causes of manifold warping
SKILLS--First Priority*
Be able to check manifold system for leaks
Be able to remove manifold
Be able to install manifold on engine
Be able to clean manifold

*All items assigned first priority.

Crankshaft and Flywheel Assemblies. Beginning tradesmen should understand the function of crankshaft and flywheel assemblies, Table 26. There are no first priority skills, but of secondary importance is the ability to measure the crankshaft and the ability to replace flywheel ring gear.

Table 26

Priority for Teaching Knowledge and Skills Relative to Crankshaft and Flywheel Assembly

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand causes of crankshaft wear
Understand function of crankshaft and flywheel assembly
SKILLS--Second Priority**
Be able to measure crankshaft for wear
Be able to replace flywheel ring gear

*Only first priority assigned.
**Only second priority assigned.

Engine Blocks. The major concern of beginning mechanics about the engine block includes an understanding of engine main bearings and the reason for their wear, Table 27. Of secondary importance is an understanding of the types of cylinder sleeves, the cause for wear, and the cause of cylinder glaze. There are no first priority skills, but of secondary importance is the ability to inspect main bearings for wear or damage.

Ignition Systems. Beginning tradesmen should, on a first priority basis, understand the theory of ignition and know the function of each part in the system, Table 28. On a secondary basis beginning mechanics should understand the operation of magnetos and the cause of ignition failure. Of major

Table 27

Priority for Teaching Knowledge and Skills Relative to the Engine Block

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand function of engine main bearings
Understand causes of wear on engine main bearings
KNOWLEDGE--Second Priority
Understand causes of cylinder sleeve wear
Understand types of cylinder sleeves
Understand cause of cylinder glaze
SKILLS--Second Priority*
Be able to inspect engine main bearings for wear or damage

*Only second priority assigned.

Table 28

Priority for Teaching Knowledge and Skills Relative to Battery and Magneto Ignition Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand theory of ignition
Understand function of ignition coil
Understand function of ignition breaker points
Understand function of ignition condenser
Understand function of ignition resistor
Understand function of ignition distributor cap and rotor
Understand function of spark plug
Understand function of ignition timing
KNOWLEDGE--Second Priority
Understand cause of ignition failure
Understand operation of magnetos
SKILLS--First Priority
Be able to remove, inspect, and replace ignition distributor cap and rotor
Be able to install ignition breaker points
Be able to install ignition condenser
Be able to service spark plugs

Table 28 (cont.)

SKILLS--First Priority (cont.)

Be able to time engine ignition system

Be able to inspect and replace ignition wires

SKILLS--Second Priority

Be able to inspect and test ignition breaker points

Be able to test condition of ignition coil

Be able to test ignition condenser

Be able to install magneto

importance is the ability to install parts of the ignition system and to time the system. Of secondary importance is the ability to test parts of the ignition system and to install a magneto.

Batteries. Knowledge relative to batteries, in terms of first priority, includes an understanding of purpose and types of batteries and charging rates, Table 29. Of secondary importance is an understanding of the effects of temperature on battery voltage and the construction of batteries. To be able to service, test, and charge a battery are the most important skills a beginning mechanic should be able to perform. Skills of secondary importance include the ability to remove and replace a battery and battery cables and to clean battery terminals.

Table 29

Priority for Teaching Knowledge and Skills Relative to Batteries

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand purpose of battery
Understand types of batteries
Understand charging rates of batteries
KNOWLEDGE--Second Priority
Understand effects of temperature on battery voltage
Understand construction of batteries
SKILLS--First Priority
Be able to service battery
Be able to test battery to determine its condition
Be able to charge battery
SKILLS--Second Priority
Be able to remove and replace battery cables
Be able to remove and replace battery
Be able to clean battery and terminals

Cooling Systems. An understanding of the purpose and function of each part of engine cooling systems is of major importance for beginning mechanics, Table 30. The most important skills include the ability to check antifreeze solution and to remove, replace, and adjust a fan belt. Of secondary importance is the ability to remove and replace water pumps, water hoses, thermostats, and fans.

Table 30

Priority for Teaching Knowledge and Skills Relative to Cooling Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand purpose of engine cooling system
Understand purpose of engine water pump on liquid cooling system
Understand purpose of cooling fan on liquid cooling system
Understand function of fan and blower on air cooling system
Understand function of cowling, baffles, and fins on air cooling system
Understand purpose of radiator pressure caps on water cooling system
Understand purpose of thermostats on water cooling system
KNOWLEDGE--Second Priority
Understand purpose of antifreeze coolants
Understand purpose of engine expansion plug

Table 30 (cont.)

SKILLS--First Priority

Be able to check antifreeze solution

Be able to remove, inspect, replace, and adjust fan belt

SKILLS--Second Priority

Be able to calculate amount of antifreeze needed

Be able to drain coolant from system

Be able to remove, inspect, repair, or replace water pump

Be able to remove, inspect, and replace water hoses

Be able to remove, inspect, test, and replace thermostat

Be able to remove, inspect, repair, or replace fan

Be able to clean fins on air cooled system

Governors. Of major importance to a beginning mechanic is an understanding of the function of governors and how they work, Table 31. The most important skill is the ability to adjust governors. Secondary level skills include the ability to remove, disassemble, repair, and reassemble governors.

Lubrication and Fuel Systems

This area includes fuels and lubricants for all types of power units and related mechanical units. In terms of importance it is ranked third. In other words, this area should be studied after a satisfactory level of competence has

Table 31

Priority for Teaching Knowledge and Skills Relative to Governors

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand the function of governors
Understand principles of governor operation
SKILLS--First Priority
Be able to adjust governor for proper engine speed
SKILLS--Second Priority
Be able to remove governor
Be able to disassemble governor
Be able to test and replace component parts of governors
Be able to assemble governor

*No second priority items

been gained in knowledge and skills relative to engines and the general area of component parts of machines. It is assumed, however, that lubricants and fuels will always be included as a part of the unit being taught. For example, it is likely that the lubrication system employed in engines could be taught best at the time engines are the center of instruction.

Lubricants and Lubricating Systems. Service managers recommended on a first priority basis that beginning mechanics understand the function of lubricants, the lubrication requirements of all mechanical units, uses of the different types of greases, and the various systems employed in oiling, Table 32.

Table 32

Priority for Teaching Knowledge and Skills Relative to Lubricants and Lubricating Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand the function of lubricants
Understand lubrication requirements of all mechanical units
Understand the different types of greases
Understand the uses of the different types of greases
Understand the conditions where grease is used rather than oil
Understand the various systems employed in oiling (pressure, wick, splash, etc.)
Understand the causes of "dirty oil"
Understand the function of oil filters
KNOWLEDGE--Second Priority
Understand the desirable properties of greases
Understand the various lubrication systems employing grease (grease cups, etc.)

Table 32 (cont.)

KNOWLEDGE--Second Priority (cont.)

Understand function of oil pumps

Understand function of oil system relief valve

Understand function of crankcase breathers

Understand the significance of SAE crankcase oil classification

Understand significance of API engine service classification

Understand significance of viscosity of oils

Understand significance of MIL specifications

Understand the significance of oil additives

SKILLS--First Priority

Be able to lubricate bearings

Be able to drain and refill transmissions

Be able to drain, flush, and refill rear axle housing

Be able to lubricate universal joints

SKILLS--Second Priority

Be able to change oil filters

Be able to clean crankcase breathers

Be able to inspect and repair oil pump

Be able to install oil pump

On a second priority basis they should understand the desirable properties of greases; the various systems employing greases; and the functions of oil pumps, oil system relief valves, and crankcase breathers. Likewise, they should understand SAE and API classifications of oils and the significance of viscosity, MIL specifications, and oil additives.

First priority skills include the ability to lubricate bearings, drain and refill transmissions and rear-axle housings, and lubricate universal joints. Second priority skills include changing oil filters; cleaning crankcase breathers; and inspecting, repairing, and installing oil pumps.

Fuels and Combustion. Beginning mechanics should, on a first priority basis, understand the causes of detonation and preignition, Table 33. At the

Table 33

Priority for Teaching Knowledge Relative to Fuels and Combustion

Knowledge by Priority Levels
KNOWLEDGE--First Priority
Understand causes of detonation and preignition
KNOWLEDGE--Second Priority
Understand cause of carbon residue
Understand classification of fuels
Understand combustion of fuels
Understand fuel-air ratios vs. horsepower and efficiency

Table 33 (cont.)

KNOWLEDGE--Second Priority (cont.)

Understand moisture and sediment content of fuel

Understand octane rating of fuel

Understand characteristics of fuel impurities

Understand flash point of fuels

Understand properties of gasoline and LP gas

secondary level of importance they should understand the cause of carbon residue, classification of fuels, combustion of fuels, moisture and sediment content of fuels, octane rating, fuel impurities, flash point, properties of gasoline and LP gas, and the relationship between fuel-air ratios and horsepower and efficiency.

Gasoline Fuel Systems. In terms of gasoline fuel systems beginning mechanics should understand the principles of carburetion and the function of each part of a carburetor, Table 34. At the secondary level of importance they should understand the function of the fuel pump and fuel filters. Also, they should understand the cause of fuel pump troubles.

As first priority skills they should be able to inspect and repair carburetors and to make carburetor adjustments. At the secondary level of importance they should be able to remove, disassemble, and assemble a carburetor; install a fuel pump; replace a fuel filter; and remove and replace fuel lines.

Table 34

Priority for Teaching Knowledge and Skills Relative to Gasoline Fuel Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand principles of carburetion
Understand function of different parts of carburetor
KNOWLEDGE--Second Priority
Understand cause of fuel pump troubles
Understand function of fuel pump
Understand function of fuel filters
SKILLS--First Priority
Be able to make necessary carburetor adjustments
Be able to inspect and repair carburetor
SKILLS--Second Priority
Be able to disassemble carburetor
Be able to assemble carburetor
Be able to remove carburetor
Be able to install fuel pump
Be able to replace fuel filter
Be able to remove and replace fuel lines

Fuel Air Cleaners. Service managers recommended, at the first level of importance, that beginning mechanics understand the function of fuel air cleaners. At the second level priority they should understand the different types of air cleaners, Table 35. In terms of skills they should be able to remove, inspect, clean, and replace air cleaners.

Table 35

Priority for Teaching Knowledge and Skills
Relative to Fuel Air Cleaners

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand function of air cleaners
Understand maintenance required for air cleaners
Understand damage caused by improper servicing of air cleaners
Understand air cleaner warning devices
KNOWLEDGE--Second Priority
Understand types of air cleaners
SKILLS--First Priority
Be able to inspect air cleaners
Be able to clean air cleaners

Table 35 (cont.)

SKILLS--Second Priority

- Be able to remove air cleaners
- Be able to replace air cleaners

LP Gas Systems. Beginning mechanics should understand, on a first priority basis, LP gas liquid and vapor systems, the nature of tanks, and the function and operation of regulators and carburetors, Table 36. At the secondary level of importance they should understand the function of the parts of the LP gas carburetor, the different types of carburetors, and the function of filters.

Table 36

Priority for Teaching Knowledge and
Skills Relative to LP Gas Systems

Knowledge and Skills by Priority Levels

KNOWLEDGE--First Priority

- Understand LP gas liquid systems
- Understand LP gas vapor systems
- Understand nature of tanks
- Understand function and operation of regulators
- Understand function of carburetors

Table 36 (cont.)

KNOWLEDGE--Second Priority

Understand function of parts of carburetors

Understand types of carburetors

Understand the function of filters

SKILLS--First Priority

Be able to test system for leaks

SKILLS--Second Priority

Be able to inspect, clean, or replace filters

Be able to set regulator valve levers

Be able to inspect, clean, and repair regulators

Be able to adjust carburetor

As a first priority skill they should be able to test LP gas systems for leaks. At the secondary level of importance they should be able to inspect, clean, or replace filters; set regulator levers; and inspect, clean, and repair regulators. Also, they should be able to adjust LP gas carburetors.

Diesel Systems. The most important things for a beginning mechanic to understand about a diesel system are the need for cleanliness, nature of fuel warning devices, function of injection pumps, types of air systems, and the types of starting aids, Table 37. At the secondary level of importance they

Table 37

Priority for Teaching Knowledge and Skills
Relative to Diesel Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand the need for cleanliness in diesel fuel systems
Understand the nature of fuel warning devices
Understand the function of diesel injection pumps
Understand the types of diesel air systems (naturally aspirated or turbo-charged)
Understand the types of diesel starting aids
KNOWLEDGE--Second Priority
Understand function of diesel delivery pump (primary)
Understand the function of return lines on fuel system
Understand types of fuel filters
Understand function of hand pump
Understand principles of fuel metering (governor action)
Understand types and operation of fuel injectors
SKILLS--First Priority
Be able to remove and replace fuel filters
Be able to purge lines in fuel system
Be able to time injection pump

Table 37 (cont.)

SKILLS--Second Priority

Be able to remove and replace lines in fuel system
Be able to remove and replace warning devices in fuel system
Be able to install injection pump
Be able to detect malfunction of injection pump
Be able to remove injection pump
Be able to remove fuel injector
Be able to test nozzle spray pattern of fuel injector
Be able to inspect, clean, and repair fuel injector
Be able to adjust fuel injector for opening pressure
Be able to make repairs and adjustments of diesel starting aids

should understand the function of delivery pumps, function of return lines, types of fuel filters, function of the hand pump, principles of fuel metering, and types and operation of fuel injectors.

The most important skills include the ability to remove and replace diesel fuel filters, purge fuel lines, and time injection pumps. At the secondary level of importance is the ability to remove and replace diesel fuel lines, remove and replace fuel warning devices, remove and install injection pumps, detect malfunction in injection pumps, service and repair fuel injectors, and make repairs and adjustments of diesel starting aids.

Electrical System and Instruments

This unit includes the general electrical system, generator and generator controls, alternators, starting motors, circuit protection devices, and instruments and gauges. This area is ranked fourth in importance by service managers for inclusion in courses of study. This simply means that attention should be given this area of instruction after a satisfactory level of competence has been achieved in the areas with a higher rank.

Electrical Systems. Beginning mechanics should understand, as a matter of major importance, the function of voltage, amperes, amp meters, volt meters, and solenoids and relays, Table 38. Also, they should understand

Table 38

Priority for Teaching Knowledge Relative to Electrical Systems

Knowledge by Priority Levels
KNOWLEDGE--First Priority
Understand function of voltage
Understand function of amperes
Understand function of solenoids and relays
Understand function of amp meters
Understand function of volt meters
Understand parallel and series circuits
Understand nature of circuit breakers

Table 38 (cont.)

KNOWLEDGE--Second Priority

Understand nature of insulators

Understand function of conductors

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parallel and series circuits and the nature of circuit breakers. Of secondary importance is an understanding of insulators and conductors.

Generators and Generator Controls. The most important things a beginning mechanic should know about generators and generator controls are the principles of generator operation, the parts of generators, and why generator controls are needed, Table 39. At the second priority level they should understand the different types of generators.

The most important skills are the ability to remove, install, and polarize a generator and the ability to replace a voltage regulator. At the secondary level of importance is the ability to test a generator's output, determine the cause of generator trouble, and disassemble and assemble a generator.

Alternators. Of major importance for beginning mechanics is an understanding of how an alternator (many brands of tractors do not use alternators) operates, Table 40. Of secondary importance is an understanding of alternator rectifiers, diodes, stators, and rotors. There are no first priority skills; however, those at the secondary level include the ability to remove and install alternators, test for proper operation, and determine if repairs are needed.

Table 39

Priority for Teaching Knowledge and Skills Relative to Generators and Generator Controls

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand principles of generator operation
Understand parts of generators
Understand need for generator controls
Understand operation of voltage regulators
KNOWLEDGE--Second Priority
Understand types of generators
SKILLS--First Priority
Be able to remove generator from engine
Be able to install generator on engine
Be able to polarize generator
Be able to replace voltage regulator
SKILLS--Second Priority
Be able to test generator's output
Be able to test generator to determine cause of trouble
Be able to disassemble generator
Be able to assemble generator

Table 40

Priority for Teaching Knowledge
and Skills Relative to Alternators

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand operation of alternator
KNOWLEDGE--Second Priority
Understand alternator rectifiers
Understand alternator diodes
Understand alternator stator
Understand alternator rotor
SKILLS--Second Priority*
Be able to remove alternator from engine
Be able to install alternator on engine
Be able to test operation of alternator
Be able to test alternator for needed repairs

*No skills listed as first priority.

Starting Motors. The most important things a beginning tradesman should understand about starting motors (starters) are the operating principles and the purposes of brushes, Table 41. Of secondary importance is an understanding of the purpose of the commutator and the starter control circuit. Only

Table 41

Priority for Teaching Knowledge and Skills Relative to Starting Motors (Starters)

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand operating principles of starting motor
Understand purpose of brushes in starting motor
KNOWLEDGE--Second Priority
Understand purpose of commutator in starting motor
Understand control circuit for starting motor
SKILLS--Second Priority*
Be able to remove starting motor from engine
Be able to install starting motor on engine
Be able to disassemble starting motor
Be able to assemble starting motor
Be able to test starting motor for repairs needed

*No skills listed as first priority.

secondary level skills are recommended; these include the removal, disassembly, testing for repairs, reassembly, and installation of starting motors.

Circuit Protection Devices. Understanding the function of protection devices is the most important thing to understand about the lighting system,

Table 42. Of secondary importance is an understanding of wiring diagrams and color codes. Also, at the same level of importance is an understanding of the

Table 42

Priority for Teaching Knowledge and
Skills Relative to Lighting System

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand function of protective devices in lighting system (fuses and breakers)
KNOWLEDGE--Second Priority
Understand wiring diagrams and color codes of lighting system
Understand nature of switches of lighting system
SKILLS--Second Priority*
Be able to replace switches in lighting system
Be able to replace fuse block
Be able to replace circuit breaker or fuses

*No skills listed as first priority.

nature of switches. No first priority level skills are recommended; however, those at the secondary level include the ability to replace switches, fuse blocks, and circuit protection devices in lighting systems.

Instruments and Gauges. Service managers recommended, at the first level of importance, that beginning mechanics understand the nature of temperature gauges and ammeters, Table 43. At the secondary level the service managers recommended that beginning mechanics understand the nature of fuel gauges, tachometers, and engine hour meters. The most important skill is the ability to replace temperature gauges. At the secondary level of importance it

Table 43

Priority for Teaching Knowledge and Skills Relative to Instruments

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand nature of temperature gauge
Understand nature of ammeter
KNOWLEDGE--Second Priority
Understand nature of fuel gauge
Understand nature of tachometer
Understand nature of engine hour meter
SKILLS--First Priority
Be able to replace temperature gauge

Table 43 (cont.)

SKILLS--Second Priority

- Be able to test all instruments for proper operation
- Be able to replace ammeter
- Be able to replace temperature bulb
- Be able to replace tachometer cable
- Be able to replace tachometer and hour meter

is recommended that beginning mechanics be able to test all instruments for proper operation and be able to replace ammeters, temperature bulbs, tachometer cables, and tachometer and hour meters.

Power Train

This mechanical area includes the clutch; transmission, differential, final drives, and axles; power take-off; and brakes. Brakes are included because they seem to be more appropriate to this area than to others.

This area ranks below the areas previously discussed. It should be included in training programs only when the other areas have been thoroughly taught. This recommendation in no way depreciates the importance of the power train; but this is a highly specialized area that, if pursued at the expense of more general areas, would tend to limit time for the development of knowledge and skills that would be of greater immediate value to beginning tradesmen.

The Power Train Clutch. The most important things a beginning mechanic should understand about the power train clutch are its function and the cause of clutch troubles, Table 44. In terms of skills he should, on a first priority basis, be able to adjust clutch linkage and to remove a clutch assembly. At the secondary level of importance he should be able to install a clutch assembly.

Table 44

Priority for Teaching Knowledge and Skills Relative to the Tractor Clutch

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand the function of clutches
Understand the causes of clutch troubles
KNOWLEDGE--Second Priority
Understand the different types of clutches
SKILLS--First Priority
Be able to adjust clutch linkage
Be able to remove clutch assembly
SKILLS--Second Priority
Be able to install clutch assembly

Tractor Transmissions. At the primary level of importance a beginning mechanic should understand the need for keeping parts clean when repairing transmissions and should understand synchronizing units of selective transmissions, Table 45. At the secondary level he should understand types and operation of selective and hydraulic activated transmissions. Likewise, he should understand controls of all transmissions and understand torque amplifier or planetary gears.

Table 45

Priority for Teaching Knowledge and Skills
Relative to Tractor Transmissions

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand need for keeping parts clean when repairing transmissions
Understand synchronizing units of selective transmissions
KNOWLEDGE--Second Priority
Understand types and operation of selective and hydraulic activated transmissions
Understand controls of all transmissions
Understand torque amplifier drive (planetary gears)
SKILLS--First Priority
Be able to drain and refill transmissions

Table 45 (cont.)

SKILLS--Second Priority

- Be able to test operation of all transmissions
- Be able to repair or replace shift linkage

The only first priority skill recommended is the ability to drain and refill transmissions. As a second priority beginning mechanics should be able to test transmissions for proper operation and be able to repair or replace shift linkage.

Differentials, Final Drives, and Axles. Of primary importance for beginning tradesmen is the understanding of the duties of differentials, final drives, and axles; the function of differential locks; and the nature of bevel drive gears. At the secondary level of importance they should understand rear-axle gear ratio, Table 46.

The most important skill recommended is the ability to drain, flush, and refill rear-axle housings. At the secondary level is the ability to remove, install, and test operation of differentials, final drives, and axles.

Power Take-Off. The most important things to understand are the different types of power take-offs and the different types of clutches that control them, Table 47. At the secondary level the nature of adjustments to be made should be understood.

Table 46

Priority for Teaching Knowledge and Skills Relative to Tractor Differential, Final Drives, and Axles

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand duties of the differential, final drives, and axles
Understand function of final drives (gears, chains, and planetary gears)
Understand function of differential locks
Understand bevel drive gears
KNOWLEDGE--Second Priority
Understand rear-axle gear ratio
SKILLS--First Priority
Be able to drain, flush, and refill rear-axle housing
SKILLS--Second Priority
Be able to remove differential, rear axles, and final drives
Be able to install differential, final drives, and axles
Be able to test operation of differential, final drives, and axles

Table 47

Priority for Teaching Knowledge and Skills Relative to Power Take-Off

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand types of power take-off
Understand types of clutches on power take-off
KNOWLEDGE--Second Priority
Understand nature of adjustments of power take-off
SKILLS--First Priority
Be able to replace safety shields on power take-off
SKILLS--Second Priority
Be able to remove power take-off
Be able to install power take-off

The most important skill recommended is the ability to replace safety shields. Secondarily, beginning mechanics should be able to remove and install a power take-off.

Braking Systems. Beginning mechanics should understand brake action and the nature of both mechanical and hydraulic systems, Table 48. The classification of brakes is considered to be of secondary importance.

Table 48

Priority for Teaching Knowledge and Skills Relative to Braking Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand brake action
Understand nature of mechanical brakes
Understand nature of hydraulic brakes
KNOWLEDGE--Second Priority
Understand classification of brakes
SKILLS--First Priority
Be able to adjust brake pedal clearance
Be able to remove brake mechanism
SKILLS--Second Priority
Be able to disassemble brake mechanism
Be able to inspect and repair brake mechanism
Be able to assemble brake mechanism
Be able to install brake mechanism

In terms of skills, it is of major importance that beginning mechanics be able to adjust pedal clearance and be able to remove brake assembly. At the secondary level they should be able to disassemble, inspect and repair, assemble, and install brake mechanisms.

Hydraulic Systems

Hydraulic systems was listed last by service managers in the order recommended for developing programs for training mechanics. This seems to be an area where a high degree of specialization is required; therefore, it was recommended by some service managers that beginning mechanics should be trained generally in hydraulics. Later, if they desire to specialize, hydraulics may be chosen as an area of specialization.

The rather large number of items suggested at the first and second priority levels should be considered as the subject matter content to be taught if sufficient time exists in the training program. Therefore, in establishing units of instruction hydraulics should be given a rather low priority; hydraulics should be taught after everything else has been taught well.

General Hydraulic Systems.

Beginning mechanics should, on a first priority basis, understand the principles of hydraulics, Table 49. They should understand the basic parts of the hydraulic system with specific understanding of the principles and function of hydraulic pumps, cylinders, valves, and filters. They should also understand the different types of pumps, filters, valves, cylinders, seals and packing, and hydraulic lines. Likewise, they should understand the need for cleanliness in working with hydraulic systems. At the secondary level of importance they should understand the different types of

Table 49

Priority for Teaching Knowledge and Skills Relative to Hydraulic Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand theory of hydraulics
Understand principles of hydraulic pump operation
Understand principles of hydraulic valves
Understand functions of hydraulic cylinders
Understand need for cleanliness in working with hydraulics
Understand parts of hydraulic systems
Understand types of hydraulic pumps
Understand types and functions of hydraulic filters
Understand types of hydraulic valves
Understand types of hydraulic cylinders
Understand types of hydraulic seals and packing
Understand types of hydraulic lines
KNOWLEDGE--Second Priority
Understand types of hydraulic systems
Understand types and functions of hydraulic coolers
Understand nature and properties of hydraulic fluids

Table 49 (cont.)

SKILLS--First Priority

Be able to check pressure of hydraulic systems

Be able to read schematic of hydraulic systems

Be able to remove hydraulic pumps

Be able to inspect, clean, or replace hydraulic filters

Be able to disassemble hydraulic cylinders

Be able to remove and repair or replace hydraulic lines

Be able to install hydraulic pumps

SKILLS--Second Priority

Be able to inspect, clean, and repair or replace hydraulic coolers

Be able to check operation of hydraulic valves

Be able to remove hydraulic valves

Be able to assemble hydraulic cylinders

Be able to install hydraulic valves

Be able to inspect, clean, and repair hydraulic cylinders

Be able to remove, inspect, and replace hydraulic seals and packing

systems, the types and functions of hydraulic coolers, and the nature and properties of hydraulic fluids.

In terms of first priority skills beginning mechanics should be able to check pressure of hydraulic systems, read schematic of systems, remove and replace pumps, service filters, disassemble cylinders, and perform service on lines. At the secondary level of importance beginning mechanics should be able to service hydraulic coolers; check, remove, and install valves; and service hydraulic cylinders.

Hydraulic Lift Systems. At the first priority level beginning mechanics should understand the principles of integral lift systems, Table 50. Likewise, they should understand the functions of the different types of remote lift systems. Also, they should understand the use and nature of quick couplers and the reason why cleanliness is so important in making hook-ups. At the secondary level of importance they should understand the parts of the different types of lifts.

There are no first priority skills; but at the secondary level of importance, beginning tradesmen should be able to disassemble remote lift systems and to make the necessary tests and adjustments required for proper operation.

Power Steering. Beginning mechanics should understand the principles of power steering and the different types of power steering systems, Table 51.

No first priority skills are recommended; however, at the secondary level they should be able to test the operating pressure of the system and be able to remove power steering units.

Table 50

Priority for Teaching Knowledge and Skills
Relative to Hydraulic Lift Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand principles of operation of integral lift
Understand function of remote lift systems
Understand types of remote lift systems
Understand use of quick couplers in remote lift systems
Understand need for couplers in remote lift systems to be clean when making hook-up
KNOWLEDGE--Second Priority
Understand basic parts of integral lift
Understand types of integral lift
SKILLS--Second Priority*
Be able to disassemble remote lift systems
Be able to test and adjust remote lift systems

*No skills listed as first priority.

Table 51

Priority for Teaching Knowledge and Skills Relative to Power Steering

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand principles of power steering operation
Understand types of power steering systems
SKILLS--Second Priority**
Be able to test operating pressure of power steering
Be able to remove power steering

*No second priority items
**No first priority items

Miscellaneous Mechanical Areas

This section includes body reconditioning, wheels and tires, steering systems, and welding. These areas are treated separately because they do not seem to fit into the categories previously discussed. No guidelines are available to suggest a priority level at which they should be assigned; however, it is the opinion of the investigator that they should not be considered as essential. Therefore, they should not be taught at the expense of more important areas.

Body Reconditioning. Beginning mechanics should understand, on a first priority basis, the proper use of cleaning materials and the purpose and methods of cleaning body parts. Secondarily, they should understand how to prepare a surface for painting and the procedure for priming and painting, Table 52.

Table 52

Priority for Teaching Knowledge and Skills Relative to Body Reconditioning

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand proper use of cleaning materials
Understand purpose and methods of cleaning body parts
KNOWLEDGE--Second Priority
Understand preparation procedures for painting
Understand priming and painting procedures
SKILLS--Second Priority*
Be able to clean body parts with chemicals
Be able to clean body parts with steam
Be able to clean body parts with air
Be able to prime and paint with spray painting equipment
Be able to mask body parts for painting
Be able to sand body parts for painting

*No first priority items

No first priority skills are recommended; but those at the secondary level include the ability to clean body parts with chemicals, steam, and air. Likewise, they should be able to prepare parts for painting and to paint with spray painting equipment.

Wheels and Tires. On a first priority basis a beginning mechanic should understand the function of tire pressure. No second priority knowledge is suggested, Table 53.

Table 53

Priority for Teaching Knowledge and Skills Relative to Wheels and Tires

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority*
Understand function of tire pressure
SKILLS--First Priority
Be able to adjust wheel bearings
Be able to replace wheel bearings and seals
SKILLS--Second Priority
Be able to change a tire

*No second priority items

In terms of skills they should be able to adjust wheel bearings and to replace bearings and seals. At the secondary level of importance they should be able to change a tire.

Steering Systems. Principles of steering gear operation is the most important thing to know about steering systems, Table 54. At the secondary level beginning mechanics should understand the different types of steering gears.

Table 54

Priority for Teaching Knowledge and
Skills Relative to Steering Systems

Knowledge and Skills by Priority Levels
KNOWLEDGE--First Priority
Understand principles of steering gear operation
KNOWLEDGE--Second Priority
Understand types of steering gears
SKILLS--Second Priority*
Be able to remove steering system
Be able to disassemble steering system
Be able to adjust steering system
Be able to install steering system

*No first priority items

No first priority skills are recommended, but at the secondary level it is recommended that beginning tradesmen be able to adjust steering systems. Likewise, they should be able to remove, disassemble, and install steering systems.

Welding. No first priority knowledge or skills are assigned in this area. However, at the secondary level it is recommended that beginning mechanics understand the conditions under which each type of weld can be used, Table 55.

Table 55

Priority for Teaching Knowledge and Skills Relative to Welding

Knowledge and Skills by Priority Levels
KNOWLEDGE--Second Priority*
Understand the conditions under which each type of weld can be used
SKILLS--Second Priority*
Be able to cut metal with oxy-acetylene torch
Be able to weld with electric arc
Be able to weld with oxy-acetylene gas

*No first priority items

In terms of skills they should be able to cut with the oxy-acetylene torch and to weld with both gas and electricity.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter is to present a summary of the study, draw conclusions, and make recommendations regarding ways and means of implementing the findings of this investigation.

Summary

The purposes of this investigation were (1) to determine the content that should be included in courses of study designed to train persons to enter the farm machinery mechanics trade and (2) to obtain information about the occupation that would be useful to persons considering the trade as an occupational goal.

Data about the occupation were obtained from managers of farm machinery dealerships; data for the "course of study" portion were obtained from service managers of farm machinery service and repair shops. All data were collected by teachers of vocational agriculture who utilized the personal interview technique after instructions were given by the investigator.

The following summary of the major findings in this study is divided into two major divisions. The first division summarizes what was found to be the nature of opportunities in the trade and includes certain personal attributes that are rather closely related to opportunities.

The second division summarizes what were found to be the most important things a beginning mechanic should know (knowledge) and what he should be able to do (skills) to make successful entry into the trade and to advance in it.

OPPORTUNITIES AND PERSONAL ATTRIBUTES

1. An extreme shortage of farm machinery mechanics exists. Eighty-eight percent of the businesses participating in this study reported mechanics to be their greatest labor need. The estimated number needed now and within the next five years exceeds 7,000.
2. Partsmen represented the second greatest need as reported by 58 percent of the farm machinery businesses participating. The estimated number needed now and within the next five years exceeds 3,600.
3. The average workweek for mechanics, as reported by participating businesses, was approximately 48 hours. The average wage reported for a top mechanic per week was $119.65 or approximately $2.50 per hour. The average wage for a beginning mechanic was slightly less than $75.00 or about $1.50 per hour.
4. Almost 90 percent of the mechanics who quit a job to accept another did so in order to earn better wages.
5. Improper attitude was reported as the major reason for "firing" mechanics.
6. The minimum age for hiring mechanics was 18 as reported by the businesses in this study.
7. Most managers preferred that mechanics be high school graduates.

8. No formal programs were sponsored within the farm machinery service and repair shops in this study for training unskilled persons to be mechanics; however, it was found that a person with basic knowledge and skills can advance through informal means provided by shop personnel.

9. It was estimated by responding managers that 2.5 years of on-the-job training would be required for a person to become a master mechanic.

10. About one week of vacation time with pay was provided mechanics each year. The amount of time varied among the responding businesses and with length of service with the business.

11. Most dealerships reported sick leave arrangements which provide benefits for employees.

12. Almost all dealerships reported some type of insurance program with joint participation between employee and employer.

13. A vast majority of managers preferred that employees have a farm or ranch background.

14. Almost 95 percent of the participating managers stated they would like to see local high schools develop programs for training mechanics. Of these, almost all stated they would assist schools with such programs.

15. Desire and aptitude were believed to be the most important factors needed for success in the mechanics' trade as stated by those managers responding.

16. Personal attributes of concern to managers were: pride in workmanship, respect for tools, cleanliness of work areas, and cleanliness of person.

KNOWLEDGE AND SKILLS--BASIC REQUIREMENTS

1. Safety was found to be the most important general knowledge a mechanic should possess.
2. The ability to use tools is the second most important asset a mechanic should possess. Special emphasis was placed upon being able to read and interpret operator's manuals and technical bulletins.
3. Beginning mechanics should own a basic set of hand tools.
4. In general, a beginning mechanic should be able to assemble new farm equipment. This area of work is not considered difficult by mechanics.
5. Less than a majority of service managers were of the opinion that beginning tradesmen should be able to adjust new farm equipment. However, these adjustments are not considered complex by mechanics.
6. Beginners who have a balance between functional understanding of mechanical units and the ability to service and repair units were preferred by the service managers responding. However, if a choice has to be made in the teaching process, it should be made in favor of understanding.
7. Service managers recommended that programs for training mechanics should begin with the engine and ignition system; then, as time permits, programs should include, in the following order, lubrication and fuel systems, electrical systems and instruments, power trains, and hydraulics.

8. As general knowledge beginning mechanics should understand the principles of power transmission and the function of clutches.

9. As general knowledge beginning mechanics should understand the function of bearings, the different types and uses of bearings, and the cause of bearing failure.

10. As general knowledge beginning tradesmen should understand the function of gears and the cause of wear on gears.

11. Beginning tradesmen should thoroughly understand the principles of internal combustion as it applies to all types of engines, know the basic parts of engines, and be able to assemble engines once they have been disassembled.

12. Beginning tradesmen should understand the theory of ignition and know the function of the parts of the system. They should be able to install parts in the system and be able to time the system.

13. A thorough knowledge of the purpose and types of batteries and the charging rates for batteries was recommended for beginning mechanics. It is of major importance that they know how to service, test, and charge batteries.

14. Beginning mechanics should understand the function of each part of engine cooling systems and be able to check antifreeze solution and to remove, replace, and adjust fan belts.

15. Beginning mechanics should understand the function of governors and be able to adjust governors.

16. Service managers recommended that beginning mechanics understand the function of lubricants, the lubrication requirements of all mechanical units, uses of the different types of greases, and the various systems employed in oiling. They should be able to lubricate all mechanical units.

17. Beginning mechanics should understand the causes of detonation and preignition.

18. Beginning mechanics should understand the principles of carburetion and the function of each part of a carburetor. They should be able to inspect and repair carburetors, and make carburetor adjustments.

19. Service managers recommended that beginning tradesmen understand the function, need for, and maintenance of fuel air cleaners.

20. Beginning mechanics should understand LP gas liquid and vapor systems, understand the nature of LP gas tanks, and the function of regulators and carburetors. They should be able to test LP gas systems for leaks.

21. In terms of a diesel system, beginning mechanics should understand the need for cleanliness, nature of fuel warning devices, function of injection pumps, types of air systems, and types of starting aids. They should be able to remove and replace diesel fuel filters, purge fuel lines, and time injection pumps.

22. Beginning mechanics should understand the function of voltage, amperes, amp meters, volt meters, solenoids, and relays in an electrical

system. They should also understand various kinds of electrical circuits and the nature and function of circuit protection devices.

23. Beginning mechanics should understand the principles of generator operation and the parts of a generator. They should also know why generator controls are needed and how voltage regulators operate. They should be able to remove, install, and polarize a generator.

24. The most important things for beginning tradesmen to know about starting motors are how they work and the purposes of brushes.

25. Service managers recommended that beginning mechanics understand the nature of temperature gauges and ammeters. They should be able to replace temperature gauges.

26. Beginning mechanics should understand the function of clutches and the causes of clutch troubles. They should be able to adjust clutch linkage and to remove a clutch assembly.

27. At the primary level of importance a beginning mechanic should understand the need for keeping parts clean when repairing transmissions and understand the synchronizing units of selective transmissions. They should be able to drain and refill transmissions.

28. Beginning mechanics should understand the functions of differentials, final drives, axles, and differential locks. They should know how to drain, flush, and refill rear-axle housings.

29. Service managers recommended that beginning mechanics understand the different types of power take-offs and the different types of clutches that control them. They should be able to replace power take-off safety shields.

30. Beginning mechanics should understand brake action and the nature of both mechanical and hydraulic brake systems. They should be able to adjust pedal clearance and to remove a brake assembly.

31. As a matter of major importance, beginning tradesmen should understand the principles of hydraulics. They should understand the basic parts of the various types of hydraulic systems. Of equal importance is an understanding of the need for cleanliness in working with hydraulic systems. In terms of skills it was recommended that beginning mechanics be able to check pressure of hydraulic systems, read schematic of systems, remove and replace hydraulic pumps, service filters, disassemble cylinders, and perform service on hydraulic lines.

32. Beginning mechanics should understand the principles of integral lift systems, understand the functions of the different types of remote lift systems, and understand the use and nature of quick couplers and why cleanliness is important in making hook-ups.

33. Beginning tradesmen should understand the principles of power steering and the different types of power steering.

34. Beginning mechanics should understand the proper use of cleaning materials and the various methods employed in cleaning body parts for reconditioning.
35. Beginning mechanics should understand the principles of steering gear operation.

Conclusions

The following conclusions seem to be justified in light of the sample taken and the treatment applied to the data:

1. A critical shortage of farm machinery service and repair mechanics exists in Texas.
2. Employers are more concerned about the personal attributes of a beginning mechanic than about the level of knowledge and skills development.

Recommendations

The following recommendations are made to implement the conclusions reached in analyzing the data in this investigation:

1. Concerted efforts should be made to encourage young men to select a career in the mechanics' trade.
2. Persons selected to be trained as mechanics should demonstrate through appropriate tests and other measures the aptitude to become competent mechanics.

3. Efforts should be made jointly by educators, industry, and other groups to expand programs for training mechanics.
4. Programs for training mechanics should be staffed with persons who have trade competence and who understand the nature of the farm machinery industry.
5. Courses of study developed to train mechanics should include experiences designed to develop the personal attributes needed by competent mechanics.

The following general recommendations were made by service managers for the development of programs for training mechanics:

> My first suggestion would be to screen the young men thoroughly as to interest, ability, health, and character. Select the best and most modern tools and machines to work with. Select modern engines and machinery to work on for training. Try to have well-arranged shops with heat for winter and cooling and fresh air arrangement for summer. You should also have facilities for cleaning parts and machines and for students to clean hands and tools and to change clothes. Try to select the best instructor possible--one who has a genuine interest in young men. He should know his business. He should, above all, be of good moral character--no bad tempers or whiskey drinkers or woman-chasers--because he will surely be a model for all the young men in his classes--good or bad. Give the instructor a small expense account so he can buy necessities for the shop without going before school board.
>
> Try to create interest through the dealership for young men to want to be a mechanic as a livelihood or challenge. The benefits and pay will have to equal or exceed other lower education vocations. Just because you teach mechanics in high school, even on a voluntary basis, it will not be enough to make a young man really want to be a mechanic. Tractors and farm machinery, particularly hydraulics, are changing fast; and someone will have to service them. But there will have to be enough interest created--pay, benefits, challenge--for a young man to choose mechanics for a living.

I am under the impression that we could take a young man with a good technical background and teach him what he needs to know, while earning a salary, in a matter of months. If he spent all of his training in actual "nuts & bolts," it would take us a longer time to teach him what he should know--I would think it would take several years. We have two 14-year-olds working as apprentice mechanics now. We have one 14-year-old, one 15-year-old, and two 16-year-olds working as new equipment set-up men. We also use these youngsters as cotton picker mechanics, and they learn and develop skill quicker than the older men. After one season on these pickers, they are capable of making field service calls on their own. John Deere is in the process of writing "textbooks" for such a course as this form would cover. The one on hydraulics is printed, and the one on electrical systems is close to being printed. The book that is out would be an ideal theory text for hydraulics.

Pick boys who really want to be mechanics. Teach the basic things that a beginner should know. We need young men in the field of mechanics very, very badly. I tried to answer this as if I was starting from scratch with a beginner.

A young man who understands the basic physics of electricity, magnetism, flow of liquids, leverage, etc., is much easier to train and will be a more valuable man in this profession.

The curriculum for farm machinery mechanics should be broken down into two parts. About 1/3 of the time should be spent in the classroom in related lecture and 2/3 in the shop in related instruction such as welding, engines, hydraulics, etc. It is important that the students learn to use modern test equipment, such as engine analyzers, hydraulic flow raters, distributor testers, valve refacers, diesel testers, and dynamometers. The basic theory and application is most important in elementary mechanics.

Impress upon young students the great shortage of mechanics in automotive and machinery businesses today.

Experience is the best teacher. The school shop should have the equipment to work on. Maybe the students could work on farmers' tractors for price of parts to get experience. Book learning is good but most shops have technical manuals to refer to. Farm machinery should be available so that students can locate parts, etc., and be able to associate with books.

Shop safety and clean parts is the beginning of the best mechanics.

Instill the desire in the student to produce more than he is getting paid to produce so that he can advance. He should be inquisitive enough to determine what is causing a part's failure instead of just replacing a part and having it fail again. He will have to study the technical books at night for the equipment he expects to work on.

A mechanic should have a number of basic skills; and with a skill, technical knowledge will come naturally. But with technical knowledge, you will not naturally attain the skills. Here are a few things that I think a man must have before he can be a successful mechanic:

(1) He must be interested in mechanic work. He must know the hardships involved and be able to cope with them.

(2) After interest comes capability. He must be able to comprehend and develop skill of mechanics.

(3) He must be of good nature to mix well with customers.

BIBLIOGRAPHY

1. Anderson, Ober J. and Clarence E. Bundy, "What Competencies Needed in Farm Credit," The Agricultural Education Magazine, Volume 39, Number 4, October, 1966.

2. Binkley, Harold, Developing Programs in Agricultural Occupations, College of Education, University of Kentucky, Lexington, 1966.

3. Dillon, Roy D. and Paul S. Cain, Employment Opportunities and Usable Agricultural Skills in Non-Farm Agricultural Occupations in Appalachia, School of Applied Sciences and Technology, Morehead State University, Morehead, Kentucky, 1966.

4. Drawbaugh, Charles C., "Base Occupational Courses on Job Analysis," The Agricultural Education Magazine, Volume 39, Number 1, July, 1966.

5. Engineering Extension Service, Suggested Basic Course Outline for Automobile Mechanics, Texas A&M University, College Station, 1964.

6. Ingram, J. Fred, What Makes Education Vocational, American Vocational Association, Washington, D.C., 1965.

7. Mabon, E. J. and Clarence E. Bundy, "Competencies Needed in County Elevator Grain Marketing," The Agricultural Education Magazine, Volume 37, Number 6, January, 1965.

8. Morphet, Edgar R., (ed.), Building A Better South Through Education, Southern States Work Conference on School Administrative Problems, Tallahassee, Florida, 1945.

9. Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools, The Interstate Publishers and Printers, Inc., Danville, Illinois, 1965.

10. Roberts, Roy W., Vocational and Practical Arts Education (second edition), Harper and Row Publishers, New York, 1965.

11. Russell, John Dale and Associates, Vocational Education, Staff Study Number 8, United States Printing Office, Washington, D.C., 1938.

12. Seventy-ninth Congress, Vocational Education Act of 1963, Public Law No. 88-210, H.R. 4955.

13. Sixty-fourth Congress, *The National Vocational Education Act*, Public Law No. 347, S. 703, Sec. 10, 1917.

14. Texas Education Agency, *Guide for Public Schools in Planning Programs of Vocational Education*, Vocational Division, Austin, 1965.

15. Texas Education Agency, *Suggested Basic Course Outline for Agricultural Machinery Service and Repair*, Austin, 1965.

16. U. S. Office of Education, *Educational Objectives in Vocational Agriculture*, Vocational Division Monograph 21 (revised in 1955), Washington, D. C.

17. Van Loh, Frederick A. and Clarence E. Bundy, "Competencies Needed by Fertilizer Retailers," *The Agricultural Education Magazine*, Volume 37, Number 6, January, 1965.